A Scranton Gillette Publication

JUNE 1961

WATER & SEWAGE WORKS

WATER SUPPLY • SEWAGE DISPOSAL

UNIVERSITY MICROFILMS
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CONT

DETROIT'S SPRINGWELLS STATION

AWWA Visits Dynamic Detroit . . . p. 207

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help reduce operating costs at South Bend treatment plant

South Bend, Indiana's sewage treatment system uses digester gas as low-cost fuel to drive sewage pumps and air compressors.

To equalize the variable gas production with demand, CB&I furnished these two 45 ft. diameter Hortonspheres®. Excess gas is stored in them at 40 lbs. per square inch working pressure—and released according to demand.

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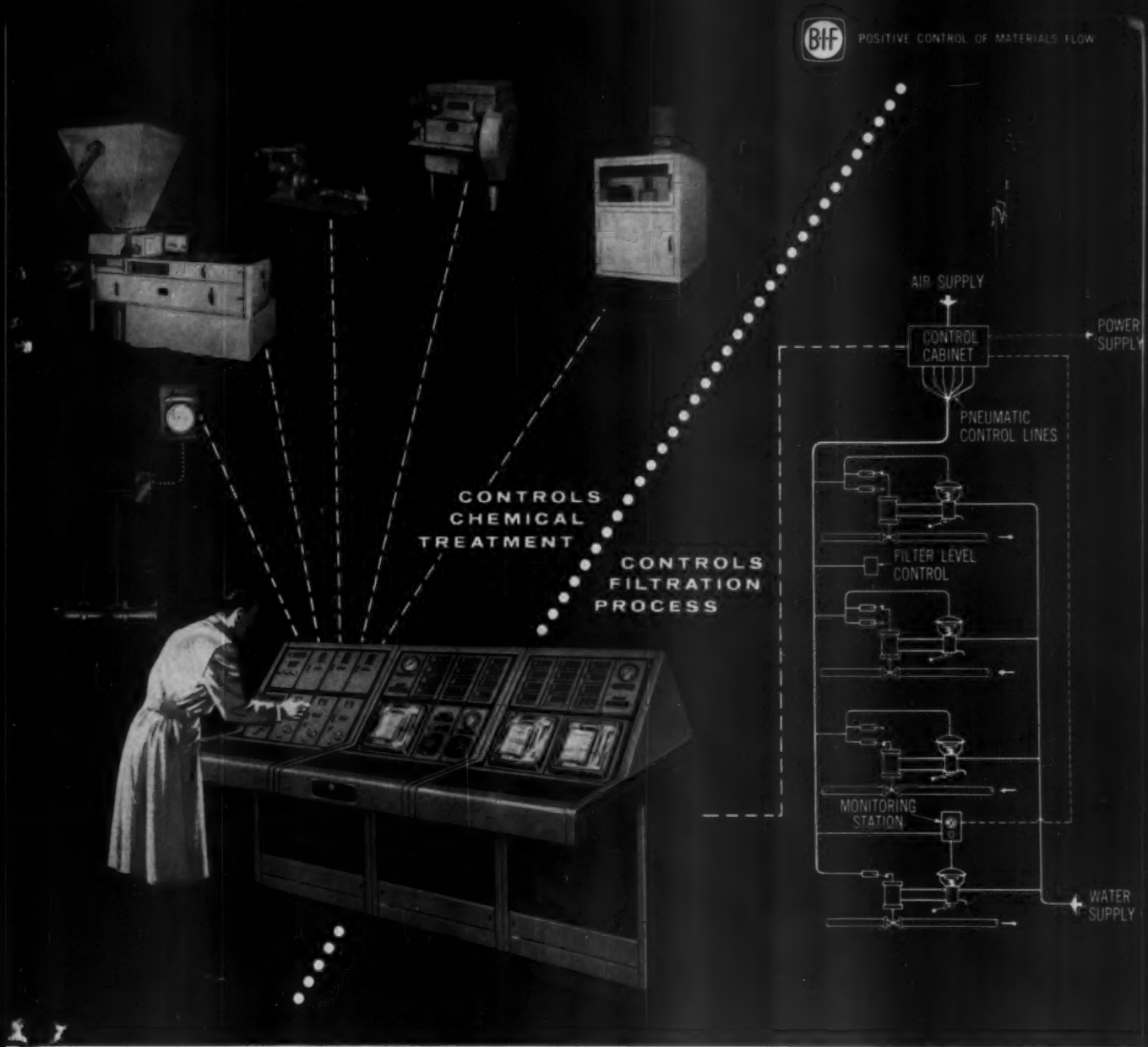

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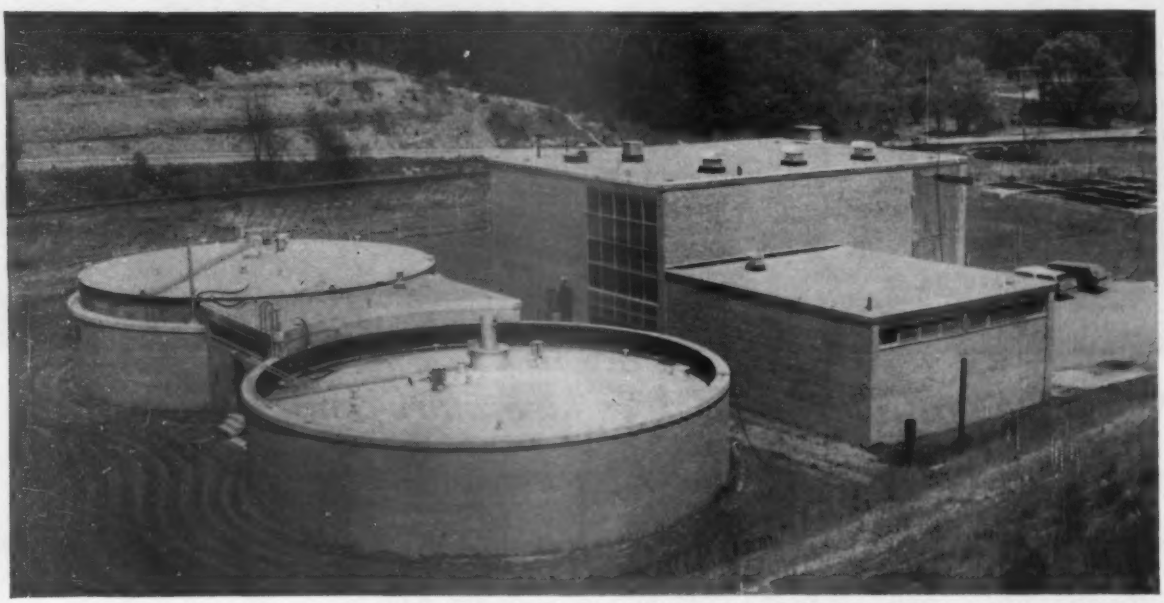

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WATER & SEWAGE WORKS

VOL. 108 **NO. 6**

JUNE **1961**

A Scranton Gillette Publication

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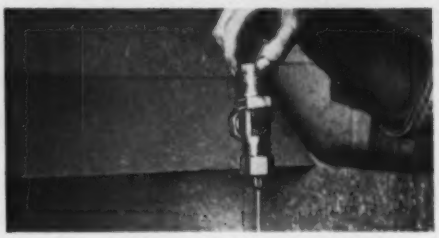
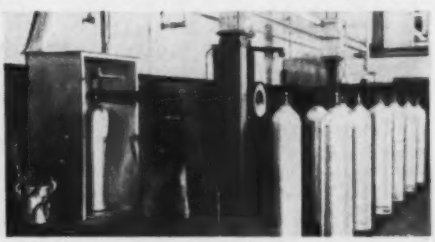


All valve parts completely reconditioned . . . valve is reassembled using all new packing . . .



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Briefs

AWWA Visits Dynamic Detroit—This year's Convention will be held in a city that has kept pace with modern expansion problems and has shaped positive plans for the future—Page 207.

Synthetic Detergents in Ground Water, Part II concludes this report of syndet pollution of Eastern U. S. ground waters—Page 210.

Gondolas in New York? It's possible, and this article explores the two facts that have given rise to this prediction—Page 214.

Automatic Control of Chemical Addition is frequently the answer to the problem of the rising cost of manpower, and to some of the problems involved in changing raw water quality—Page 217.

Evaporation Suppression Research (Research Progress Report), Part II concludes this series of recent advances by discussing laboratory and pilot scale work being carried out at Stanford University—Page 221.

Butterfly Valve Actuators—Part I of this three-part series discusses the construction and operation of manual operators—Page 226.

Site Conferences is a *Confidential* report by Partially Oriented on how to conduct meaningful conferences in the field—Page 230.

New Platinum Electrode System Measures DO and BOD describes the use of a polarographic oxygen electrode yielding accurate and reliable results comparable to the standard Winkler method—Page 231.

Editorial—The Need is Great assesses the need for action and leadership in the field of water supply as a public service—Page 237.

Measuring Coliforms in Water (Research Progress Report) compares a modified MF technique with the standard multitube dilution procedure —Page 238.

Instrumentation in Water Pollution Control discusses the problems confronting continuous analytical instrumentation in monitoring stream pollution—Page 244.

Placing a Submerged Ocean Outfall—Installed on the floor of Santa Cruz Bay, California, this outfall was the first fixed slope and the heaviest outfall pipe pulling project on record—Page 246.

Culture and Harvesting of Attached Algae Grown on oDmestic Sewage (Research Progress Report) Part I tells of an investigation being made of related literature and in the field to discover and study attached algae suitable for growth in sewage—Page 248.

ON THE NATIONAL SCENE

A $100-MILLION PER YEAR water pollution control program is the goal of Secretary of Health, Education and Welfare Abraham A. Ribicoff. He told the House Public Works committee that the present $50-million per year federal grant program is inadequate to provide for the current need for more than 5,000 municipal waste treatment plants. The committee has tentatively approved the $1-billion Kennedy recommendation.

SETTLEMENT of the Federal Government's first suit under the enforcement provisions of the Federal Water Pollution Control Act was culminated in St. Joseph, Mo. recently by referendum vote. The vote OK'd a $5.9-million bond issue, the proceeds of which will be used to build sewage processing facilities for the city. While local industry, accused along with the city, agreed to refrain from dumping their wastes into the Missouri River, the city refused to cooperate on two previous referendums.

A RESOLUTION to guarantee increased water storage capacity in five Federal reservoirs has been given final approval by the Kansas legislature. The legislature's action was described as charting a new course for the state in its pledge that the state or its political subdivisions would fulfill their obligations to pay for the water when used. Kansas was further described as the first state to meet requirements of a 1958 Federal Law for guaranteeing payment to enable the Corps of Engineers to add increased water capacity to certain reservoirs before the state or cities are ready to use the water.

BILLS to virtually rewrite Oregon's air pollution law and to give the State Sanitary Authority more power to clean up the state's rivers and streams were passed by the State Senate and sent on to the House. Farm activities and home barbecuing are exempted from the air pollution bill. Under the bill the State Authority would have the right to review and approve all industrial air cleaning devices.

SERIOUS DROUGHT could drain the Potomac River dry, according to a warning issued by Harry A. Boswell, chairman of the Maryland Economic Development Commission. Boswell said that the Washington-Baltimore area's increasing water requirements demand "emergency attention." In calling for an interstate conference on the Chesapeake Basin's water resources, he said that metropolitan growth, industry and irrigation are consuming twice as much water as 30 years ago. If a drought like 1930 should strike again, he asserted, this rate of consumption would exhaust the river completely.

A BILL TO AUTHORIZE OHIO to join the Great Lakes Basin Compact has been introduced in the Ohio House of Representatives. While Ohio is the sole non-member state bordering the Great Lakes, similar bills have failed on three previous occasions. The Great Lakes Commission does technical studies, prepares reports, serves as a clearing house for information and recommends policies and programs.

TWO OTHER STATES may also get together. A California-Nevada compact commission has approved a draft to further intergovernmental cooperation on water resources.

TAKE "IMMEDIATE STEPS" to build the needed sewage treatment plant was the order to the City of Wilkes-Barre, Pa., by the Pennsylvania Sanitary Water Board. Dr. C. L. Wilbar, Jr., said the city has two years to build the plant and stop dumping its 13-million gallons of raw sewage per day into the Susquehanna River.

SALE OF THE FIRST $15-MILLION in water bonds, part of a $40-million issue approved by voters two years ago, has been approved by Denver, Colo., city councilmen. The $40-million issue, coupled with a $70-million issue in 1955 will more than double Denver's available water supply.

JUNE, 1961

LOWEST COSTS EVER for converting sea water into fresh water are claimed for a newly-designed desalting unit designed by Fairbanks Whitney Corp., in a joint venture with the State of Israel. Process employed has evolved from the vacuum freezing technique developed by Israeli scientist Dr. Alexander Zarchin. While ground has just been broken for the conversion plant in Elath, Israel, testing of the conversion unit has gone on for some time. The unit has tested out to provide fresh water for less than $1.75 per thousand gallons in commercial quantities. When installed, the first unit, together with others to be installed in the coming months, will produce approximately 250,000 gallons per day.

STIMULATED by Pennsylvania's disastrous 1955 flood and predictions of a population explosion to 30 million in the next 20 years, the governors of New York, Pennsylvania, New Jersey, Delaware, and the Mayors of New York City and Philadelphia have approved a Delaware River Basin Compact, the first of its kind in the U.S. It will set up a regional agency to be managed by the four states and an appointee of the President. If everyone approves, it will be the first time the Federal government has become signatory with states in a regional compact.

FEASIBLE METHODS of treating secondary sewage treatment plant effluents so that waste water can be used again and again is being studied by Dow Chemical Co.'s Industrial Service division. Various activated carbons will be studied as possible agents in the purification process. The work is being done under a contract with the U.S. Public Health Service. Says USPHS: "In the face of a naturally fixed water supply, the growing needs of an expanding population and industrial complex will require that water be used over and over again...The development of satisfactory techniques for doing this represents a major, challenging research problem."

FLUORIDATION GAINED SOMEWHAT during the past year, but election records were still solidly against the process. In 56 elections in the U.S. last year, only 13 cities elected to allow it.

IDAHO'S GROUND WATER CODE may get its first court tests in the light of severe water shortage forecasts. Indications are that many Idaho farmers will have to curtail their farming operations to less than 50 percent of their normal water supply. The code establishes a priority system on water drawn from wells and restricts drilling in areas where it is determined water is insufficient to provide adequate supplies if the number of wells is increased. Prior water rights are given to users from streams and rivers.

FIFTEEN TIMES MORE WATER will be demanded in the eastern U.S. by 2000 than seven years ago, according to a prediction made by Assistant Secretary of Agriculture, Frank J. Welch. To overcome some of the problems brought about by the tremendous demand, Mr. Welch suggests looking into experimental saline water conversion, including localized induced rainfall.

ILLINOIS INDUSTRIES are using 43 per cent more water today than 10 years ago, the Illinois Water Survey reports. Water now used by industry, excluding hydro electric uses, now totals about 12-billion gallons per day in the state.

AN UNDERGROUND CONSERVATION LAW has been signed by Utah Governor Rutter to provide the state with the same water conservation for underground sources as for surface water conservation. Under the law, the state engineer will be responsible for setting up rules and regulations for drilling and will be the sole arbiter in the event of dispute.

CONTRACT for the world's largest prestressed-concrete reservoir has been let to The Preload Co. Inc. The reservoir will be twice the volume of the largest prestressed reservoir to date. Capacity will be 28-million gallons. It will be 370 ft in diameter and 27 ft 6 in. high. Cost approximately $600,000.

GRAVER TANK & MFG. CO. a division of Union Tank Car Co., and Western-Knapp Engineering Co. have been awarded an $8-million contract to build surge tanks, penstocks, and risers for the Oahe hydro project, world's largest rolled earth dam.

News—Here & There

Books Received

Proceedings of the National Conference on Water Pollution. U. S. Department of Health Education and Welfare, U. S. Government Printing Office, Washington, D. C., 1961 ($2.25, paper). This is a verbatim transcript of all papers presented at the December 12-14, 1960 Conference. Also appended are statements submitted by various individuals, plus a list of motion picture films selected because of their water pollution control aspects.

Sewage Treatment, Basic Principles and Trends. R. L. Bolton and Louis Klein, Butterworths, London, 1961 ($5.50), 156 pages.

Water Supply and Waste Disposal. W. A. Hardenbergh and E. R. Rodie, International Textbook Company, Scranton, Penna., 1961 ($11.00).

Centrifugal Pumps. Igor Karassik and Roy Carter, F. W. Dodge Corporation, New York, 1960 ($15.75), 464 pages.

1301 *Review Problems.* R. C. Brinker, J. J. Bourquin, J. A. Whitacre, Jr., P. C. Hassler, and P. W. Young, International Textbook Company, Scranton, Penna., 1960 ($7.50), 345 pages.

Water Supply and Sewerage. E. W. Steel, Fourth Edition, McGraw-Hill, New York, 1960 ($11.00), 626 pages.

Dictionary of Mechanical Engineering. Alfred Del Vecchio, Philosophical Library, New York, 1961 ($6.00), 346 pages.

Book Review

Perhaps one of the best ways to arouse the public to the needs in natural resource conservation is to write a book phrased in terms everyone can understand. Senator Robert S. Kerr's book* does this very well, using homely bits of philosophy and life-like incidents to make his points hit their mark.

Among the National programs he endorses are: the Tennessee Valley Authority, Public Power, multiple use water storage reservoirs, reforestation, and his pet project: intensive development of the Arkansas, White and Red Rivers. In all these areas, plus some of local flavor, considerable interesting and pertinent background is provided. Also, many people are named by Senator Kerr who might not normally be nationally recognized for their dedicated work in resource conservation programs.

**Land, Wood & Water*, by Senator Robert S. Kerr, edited by Malvina Stephenson and Tris Coffin. Fleet Publishing Corporation, New York, 1960, ($4.95), 365 pages.

General Waterworks Corporation; 1960 Report To Stockholders

Earnings, assets, gross revenues and most other facets reached new highes in 1960 in the General Waterworks Corporation, according to the 1960 Annual Report to Stockholders.

Most of the impetus in raising revenues to record levels, the report states, came from growth in the number of customers and telephone subscribers served together with the rate increases.

Higher rates totaling $100,000 have been received and applications for $800,000 more in rate increases are to be filled during 1961.

Rate increases totaled $400,000 of which $215,000 was reflected in 1960 operations.

General's water system added more than 8700 customers last year of which 2500 were obtained by property acquisitions. In January of this year 2700 more customers were added with acquisition of the New Castle County Water Company in Delaware.

General Waterworks reported consolidated net income of $3,496,430 for 1960 equal after preferred dividends payments to $1.89 a share on an average of 1,162,636 common shares outstanding.

CONTINUED ON PAGE 10A

W&SW FUTURE FEATURES . . .

Manuscripts Scheduled for the Next Few Issues of W&SW

Pollution—Urban Vs Rural in Imperial Valley Waters—Part 1

Harvey F. Ludwig, Andrew L. Gram and Joseph L. Feeney
Engineering Science, Inc., Arcadia, Calif.
Begins comprehensive report of Southern California water pollution study. Compares domestic and agricultural coliform and BOD loadings.

An Improved, Short-Term, BOD Test

A. W. Busch
Rice University, Houston, Texas
A Research Progress Report describing the search for a 24 hour total oxygen demand test.

Butterfly Valve Actuators—Part 2

A. L. Myers
Allis-Chalmers, York, Penna.
Describes selection and use of electric motor operated butterfly valves for control.

Culture and Harvesting of Attached Algae Grown on Domestic Sewage—Part 2

G. W. Reid and J. R. Assenzo
University of Oklahoma, Norman, Okla.
Concludes two-part Research Progress Report by describing laboratory studies and pilot plant operation.

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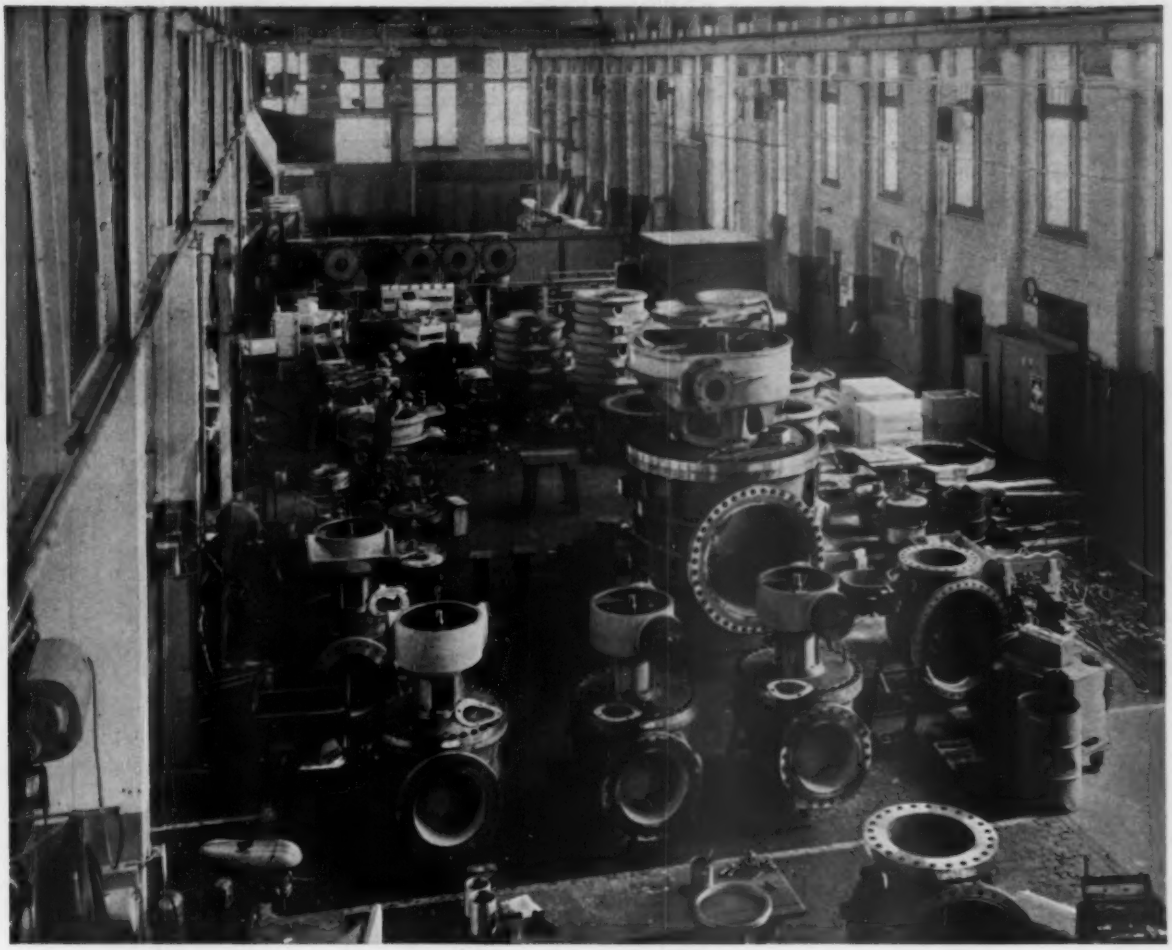


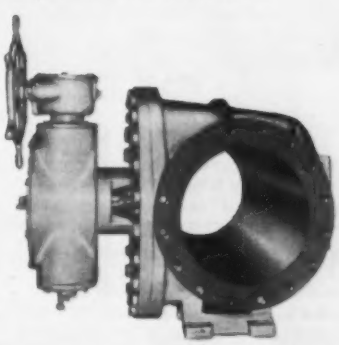
Another shipment of "habit-forming" valves

built for performance that always captures repeat customers!

Here we see one small part of the latest shipment of Allis-Chalmers valves destined for a long-time customer. These units will augment hundreds of A-C valves already installed in the same western metropolitan water system, many of them tracing satisfactory service back a quarter of a century!

Shown are four 300-lb, 24-in. *Rotovalve* units (two motor-operated, two manual) . . . a 48-in. cast-steel *Rotovalve* for 300 psi (motor-operated) . . . and several butterfly valves of the 136 ordered (all rubber-seated, motor-operated, ranging in size from 12 to 48 inches).

Allis-Chalmers offers today's only complete, perpetual rotary-valve stocking program, assuring you fastest delivery, thanks to "off-the-shelf" availability. For help anytime, contact your nearby A-C valve representative, district office, or simply write to **Allis-Chalmers,** *Hydraulic Division, York, Pa.* A-1395



The ROTOVALVE is probably your best all-round buy in a valve. Wide open it has no more resistance to flow than a straight piece of pipe of equivalent length. Actually seats itself tighter with use. *Rotovalve* is an Allis-Chalmers trademark.

News—Here & There

CONTINUED FROM PAGE 8A

Resources for the Future, Inc., Annual Report for 1960 Released

Resources for the Future, Inc. (RFF) was established in 1952 with the cooperation of The Ford Foundation. Through grants from its sponsor, RFF finances research and education in development, conservation, and use of natural resources. The 1960 report includes three special presentations: A Better Gauge of the Water Outlook, The Outlook for Nuclear Energy, and Measuring Regional Growth. Also, a detailed review of the year's work notes those activities which were begun, completed, or otherwise advanced to some definite new stage. This latter category includes extensive work in the field of water resources.

British Water Research Association News

The Water Research Association, formerly of 18 Linkfield Lane, Redhill, Surrey, England, has moved to the following new address:

Ferry Lane,
Medmenham,
Marlow,
Buckinghamshire, England.

Reader Response

Water Research

Sir—I wish to take friendly exception to a part of your editorial on the AWWA in the March issue of WATER & SEWAGE WORKS.

First, however, I wish to compliment you on the second paragraph of that editorial. Your conclusions . . . . . I believe, are excellent. I am afraid it will not be possible for the (management) consultant to be selected and at work before Detroit Conference time. This is because . . . the complete Aims and Objectives (Committee) report (has been) submitted to the (now) five Standing Committees of the Board for their recommendations before the consultant was engaged . . .

I must take issue with the last statement of your third paragraph. I do not feel that the Board acted from expediency or, as a matter of fact, that they "diluted" the recommendations of the Subcommittee on Research . . .

. . . the Board felt that it must "walk before it could fly" and that the first step toward a research program should be the compilation of a list of all the research work which is now being done . . .

The important thing to remember is that the Board was trying to keep the door open without committing us to a larger dose than we could swallow. I assure that . . . final action of the Board on the A and O report was anything but a "rubber stamp" operation . . . the members of the Board deliberated and discussed it, and I am very proud of the manner in which they handled it.

John W. Cramer
Vice President
AWWA
Lincoln, Nebraska

The A and O subcommittee on Research recommended that a Water Research Institute be established in affiliation with AWWA to, among other things, encourage, support and conduct research. The AWWA Directors last January acted on the A and O report, decided to name another committee and told it to ". . . develop a program of research . . . , make recommendations for the establishment of a permanent research foundation within the framework of the Association, and develop a program". The Board would later consider employing a technical staff "to implement the recommendations of the Committee". Our March editorial called this action a hesitating half step . . . into a full-fledged research program. In other words, we believe AWWA should have hired help now to implement the first step of collecting available data. We do not believe the Committee should be told by the Board to recommend a research establishment within the framework of AWWA. This may not be the best way of getting the job done.—Ed.

Dissolve the Apparent Need

Sir—Your editorial, "Dissolve the Apparent Need", in the April, 1961, issue of WATER & SEWAGE WORKS is both timely and very much to the point.

For a long time now I have agreed with the now expressed opinions of my old friends, Abel Wolman and Richard Hoak that there is too much emphasis being placed on saline water conversion. I have stated to many persons that if the Government would put as much energy and money on encouraging the reuse of water and the elimination of water waste, there would not be need for the heavy expenditures on saline water conversion experiments.

. . . people are not going to pay $1.00 or more per thousand gallons of water as long as they can get it for less. Sewage and industrial waste effluents can be made usable for many non-potable purposes at considerably less than $1.00 per thousand gallons.

. . . there is very much need, in my opinion, for sensible approach to this problem.

E. B. Besselievre P. E.
Fellow & Life Member ASCE
Dallas, Texas

Water and Sewage Works likes to hear from its readers. Reader Response will continue to air readers' beliefs, but keep them short and current, please. Send your response to Editor, Water and Sewage Works, P.O. Box 1315, Lansing Michigan.

Sir—Noted with interest contents of A. P. Jones' letter (Reader Response, March W&SW) . . . especially remarks about advertising, etc.

Several years ago I suggested the idea of a current calendar under "Meetings, What, When, and Where" to the late Linn Enslow . . . he liked it and used it. Naturally, I do too, because it is a simple matter to adjust dates at a glance. And it's my idea.

Keep up your good service to readers.

M. J. Siebert
Westmoreland, Virginia

Sir—It was gratifying to me to find in your last issue . . . the articles by Moses and Gamble. These were papers which they presented at our 1959 meeting, and I am glad that they now have the wider circulation which your magazine gives them.

John H. Murdoch, Jr.
President
Eastern Water Company Conference
Ardmore, Pennsylvania

Sir—I would like to suggest that your magazine have holes along one side, as well as perforations, for loose-leaf notebook and tearing-out, respectively. It is not easy to store complete magazines for future reference, but individual articles could easily be kept in notebooks, if it were easier to get the pages out . . .

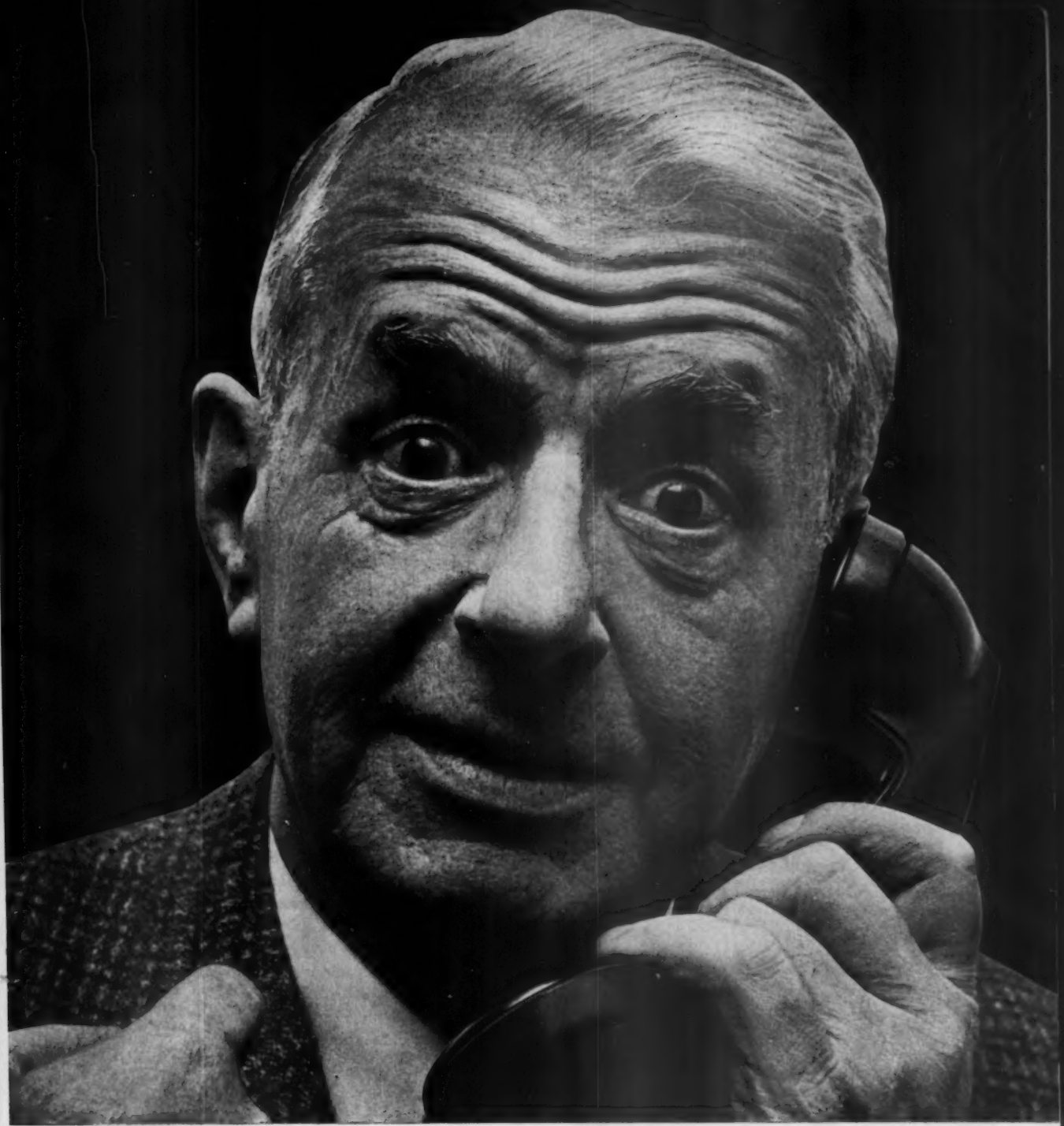
Richard E. Carpino
Public Health Sanitarian
Watertown, Conn.

Excellent idea, how many other readers agree?—Ed.

Sir—You are doing a fine job and we always enjoy reading your interesting magazine.

Would you please send us a copy of your compilation of laws applying to water supply, quality and distribution by John H. Murdoch?

Harley C. Boeke
General Manager
Ottumwa (Ia.) Water Works



"He's calling me the idiot!"

"Of all the nerve! I oughta remind His Honor that *he* hired the guy who wrote up the pump specs. No experience clause . . . and who's low bidder? Some outfit that builds *bilge pumps!* The Mayor should hear those things howl and vibrate! Sure they meet rated capacity, but all the bearings are so hot it smells like we're barbecuing grease! Next time I'll make darn sure we get that experience clause *in*."

Comprehensive *experience* in pumps — an important benefit that's yours when you deal with Allis-Chalmers. Industrial Equipment Division, **Allis-Chalmers,** Milwaukee 1, Wisconsin. A-1501

ALLIS-CHALMERS — 92 YEARS OF PUMP EXPERIENCE

Allis-Chalmers has a pump-building history going back over 90 years. In 1888, we developed the largest centrifugal pumps of that time . . . and they are still operating. Through a program of sound, gradual development, Allis-Chalmers pump designs are improved regularly with tested ideas . . . no idea goes into production for our customers until it has been proved sound in tests.

City of Kaufman, Texas,
Water Treatment Plant shows

Simplified installation of porous plate underdrains for long, trouble-free service

The nearly completed porous plate bottom shows how the City of Kaufman, Texas, planned for maximum simplicity of construction and freedom from water filter problems.

The plates are ALOXITE® aluminum oxide, laid on concrete piers with the hold-down bolts embedded during construction. Plates are fitted with a synthetic plastic gasket manufactured by Christy Firebrick Co., 506 Olive St., St. Louis, Missouri. No jointing is required. When the hold-down bolts are tightened, a bead around the gasket insures a tight, continuous seal. Angle iron at the junction of the wall and bottom completes the installation.

"With ALOXITE porous filter bottoms we're avoiding future problems," says Mr. Carroll Wallace, Superintendent of the water treatment plant. "There should be no difficulties with backwashing — no upset beds, no blow holes or mudballs, no frequent pulling down of filter beds for cleaning. ALOXITE underdrain plates help answer today's needs for trouble-free operation and minimum of maintenance."

CARBORUNDUM®

Dept. X-61, Refractories Division, Perth Amboy, N. J.

AMERICAN *Water Meters*

A SIZE AND MODEL TO MEET EVERY REQUIREMENT

Just one QUALITY... *the Finest!*

Smallest American Meter, 5/8" x 1/2" . . . largest, the 6" Heavy Duty Meter. Solid Casing and Frost Bottom types . . . capacities from 20 GPM to 1000 GPM — to meet every water requirement. Add to this large range in sizes, the most complete design flexibility of any meter and you have the reason why so many water utilities specify AMERICAN.

Every AMERICAN Meter, regardless of SIZE, has the basic, built-in features of unmatched construction simplicity, unequalled measuring accuracy, and the widest range of parts interchangeability.

Every AMERICAN Meter is a measuring instrument of the highest quality, built to last longer, with the least maintenance; to provide greater earnings and better public relations.

Subsidiary of AMERICAN METER COMPANY

For complete details, write for Bulletin 58

BUFFALO METER COMPANY, INC.

Dept. WS, 2917 Main Street • Buffalo 14, N. Y.

300 North Gilbert Avenue • Fullerton, Calif.

Sales representatives throughout the nation

U.S. cast iron PIPE FOR WATER, SEWERAGE AND

easy does it

Nothing like the new USIFLEX® Boltless Flexible Joint Pipe for underwater installations.

Easy does it. No bolts, nuts, wrenches. Assembles fast with only a moderate thrust needed to move ball past self-sealing gasket into socket. Retainer ring provides positive lock against pull-out.

Here's the new answer to the old problem of laying underwater pipe quickly, economically, profitably. Call or write for our illustrated booklet.

U. S. PIPE AND FOUNDRY COMPANY
General Office: Birmingham 2, Alabama

A Wholly Integrated Producer from Mines and Blast Furnaces to Finished Pipe.

USIFLEX®
BOLTLESS FLEXIBLE JOINT* PIPE

*U. S. Patent No. 2,564,938

INDUSTRIAL SERVICE CAST IRON

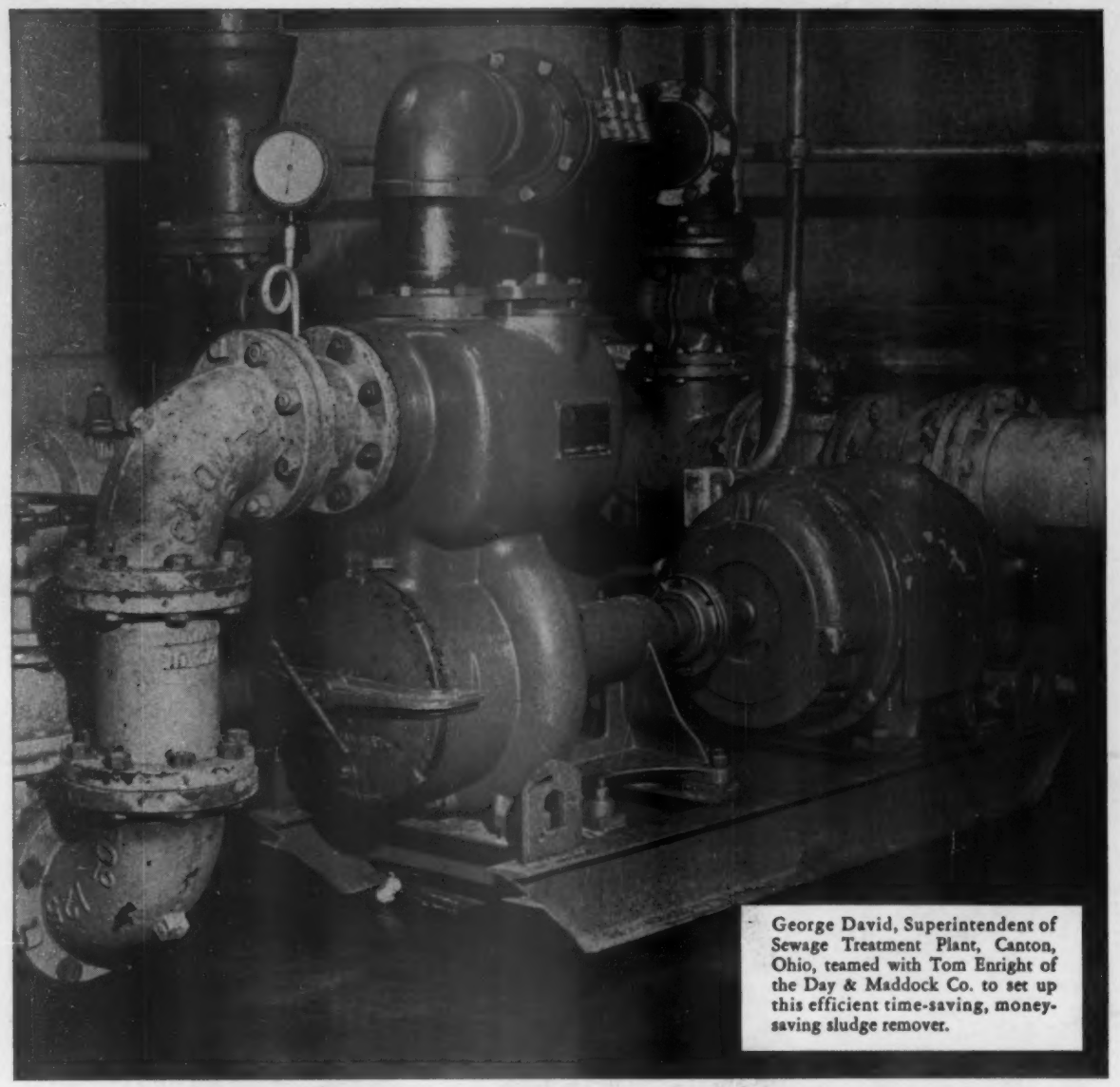
1 Insert the gasket in its seat in the socket. Forming gasket loop helps initial stage of seating. Release of loop allows gasket to spring into the gasket seat where it is securely held.

2 Apply special Usiflex lubricant to the ball and inside surface of seated gasket in socket. After lubrication, ball is ready to be pushed into socket.

3 Ball has been socketed. Retainer ring lugs have been lined up with recesses in bell and retainer ring is ready to be moved into the bell and rotated.

4 After insertion and rotation of retainer ring in bell, the lugs on retainer ring are in back of and in register with internal flange segments in bell. Lead lock is partially inserted into recess between the bell and retainer ring.

5 Lead lock completely inserted in recess is being caulked in place by hammer blows on a wide caulking iron.



George David, Superintendent of Sewage Treatment Plant, Canton, Ohio, teamed with Tom Enright of the Day & Maddock Co. to set up this efficient time-saving, money-saving sludge remover.

RECIRCULATION AND CLEANING PUMP SOLVES CANTON DIGESTER PROBLEM

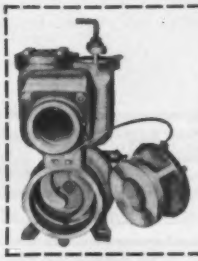
Gorman-Rupp Sewage Pump cleans with no downtime and major savings

Problem—To remove 7-years' accumulation of sludge from 10 huge digesters. With mechanical shoveling devices, it cost $5000 to clean only one digester. And during cleaning, digester was totally inoperative for 6 weeks.

Answer—A Gorman-Rupp Model 16A2-B Pump. Its unique action first agitates sludge into a common mixture by circulating digester liquid under pressure. Then, with valves reversed, pump draws off liquid and suspended solids for disposal.

Result—Each digester could be cleaned in only 21 days. Only outlay is cost of 6″ pump, electric motor, and labor of opening and closing 2 valves twice a day.

4″ and 6″ pumps can be connected to your power or ordered complete with power units. Write for complete specifications.



Fast-Action End Plate. Releases for access to impeller and renewable wear plate. Impeller is 2-vane trash type that handles spherical solids up to 2½″ in diameter.

THE GORMAN-RUPP COMPANY

305 Bowman Street • Mansfield, Ohio

GORMAN-RUPP OF CANADA LTD.

St. Thomas, Ontario

One of Southern California's largest home developments, Eastgate, assures low-cost, efficient water service for its 2250 homeowners with "K&M" Asbestos-Cement Pressure Pipe.

22 MILES OF "K&M" ASBESTOS-CEMENT PRESSURE PIPE ASSURE

dependable water service for a spanking new city of 10,000!

Modern cities like Eastgate spring full-grown from the earth—complete with homes, schools, shopping center and even a hospital. To make such a city a reality calls for modern methods and modern materials, such as "K&M" Asbestos-Cement Pressure Pipe. This rugged pipe was the builder's choice for its freedom from maintenance and for its durability. He knows today's particular home buyers demand materials that function without failure for years and years. Another important factor was the ease of installation and handling "K&M" Asbestos-Cement Pressure Pipe offers. Robert Kennedy, of Kennedy Pipe & Supply Company, tells you, in his own words, how "K&M" Asbestos-Cement Pressure Pipe helped him adhere to a tight schedule.

"THE 'K&M' FLUID-TITE® COUPLING HELPED US LAY MORE PIPE PER HOUR!"

"We had no trouble keeping up with the builder's tight schedule with 'K&M' Asbestos-Cement Pressure Pipe and the 'K&M' FLUID-TITE Coupling. All we had to do was lubricate the pipe end, and slide it into the coupling. This gave us a joint tight under all operating conditions. We didn't need any heavy machinery or coupling pullers. 'K&M' Pipe was lightweight and easy to handle, which permitted us to work smoothly. It reduced our installation time and costs considerably."

Robert Kennedy, President, Kennedy Pipe & Supply Company, Paramount, Calif.

After it's in the ground, "K&M" Asbestos-Cement Pressure Pipe is practically indestructible. It won't tuberculate. This assures the taxpayer of the same water flow and pressure years later, that he had when his home was new. Pumping costs remain low. Joints stay watertight. In addition, this pipe resists corrosion, and is immune to electrolysis.

For more information write to: Keasbey & Mattison Co., Ambler, Pa.

K·M BEST IN ASBESTOS

Keasbey & Mattison at Ambler

The light weight of "K&M"® Asbestos-Cement Pressure Pipe permits you to lay most sizes by hand . . . and reduces shipping costs.

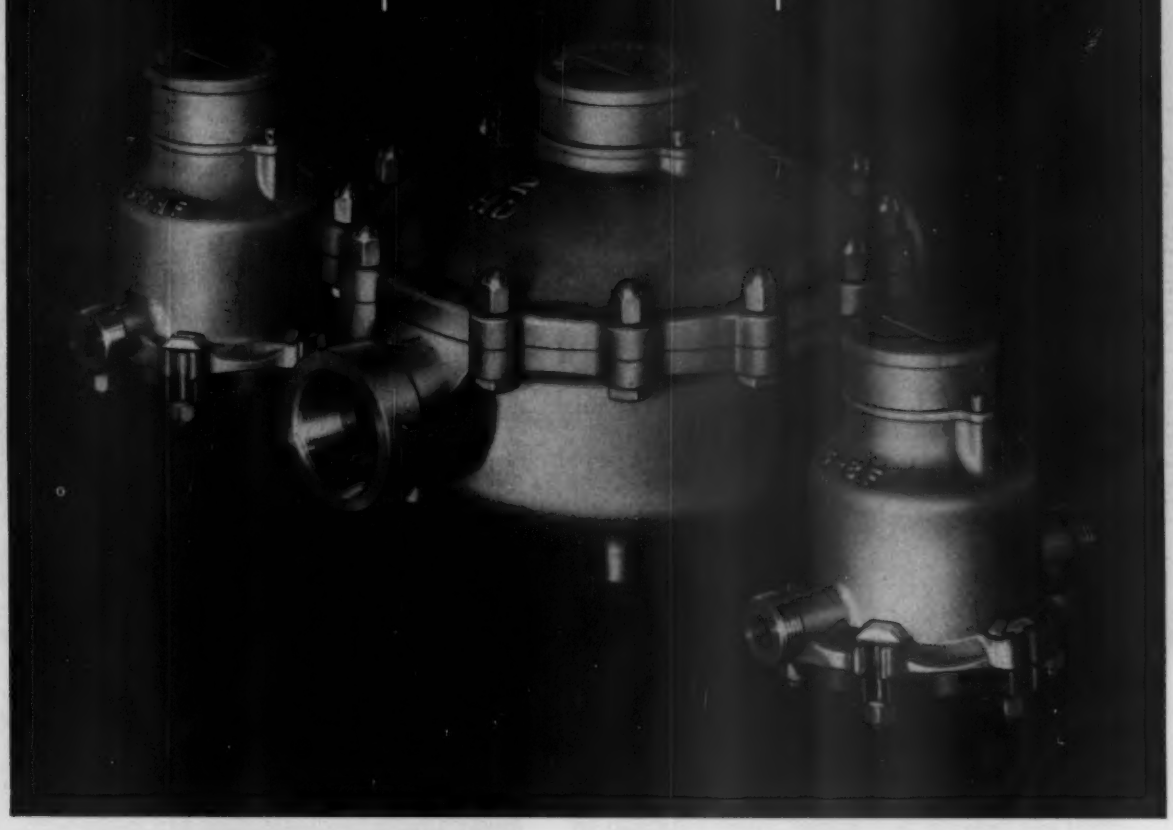
Assembling the exclusive, patented "K&M" FLUID-TITE® Coupling and Pipe takes but an instant.

HERSEY

MODEL HF
with Frost Protection bottom.
$\frac{5}{8}'', \frac{5}{8}'' \times \frac{3}{4}'', \frac{3}{4}'', 1''$ sizes.

MODEL HD
for use where freezing will not be encountered.
$\frac{5}{8}'', \frac{5}{8}'' \times \frac{3}{4}'', \frac{3}{4}'', 1'', 1\frac{1}{4}'', 1\frac{1}{2}'', 2'', 3''$ sizes.

MODEL F
with Frost Protection bottom.
$\frac{5}{8}'', \frac{5}{8}'' \times \frac{3}{4}'', \frac{3}{4}'', 1''$ sizes.



INSIST ON THE METERS WITH WATER BALANCED PISTONS

. . . for greater accuracy
. . . lower maintenance costs

The conical disc piston in these Hersey water meters literally *floats* . . . practically eliminating thrusts. Result: greater sensitivity and accuracy . . . lower maintenance costs. Write for descriptive catalogs.

Hersey-Sparling
Meter Company
HERSEY PRODUCTS
DEDHAM, MASSACHUSETTS

Branches: Atlanta, Boston, Chicago, Cleveland, Dallas, Denver, Kansas City, Mo., Los Angeles, New York, Philadelphia, Portland, Ore., San Francisco, Seattle.

ideas and news:

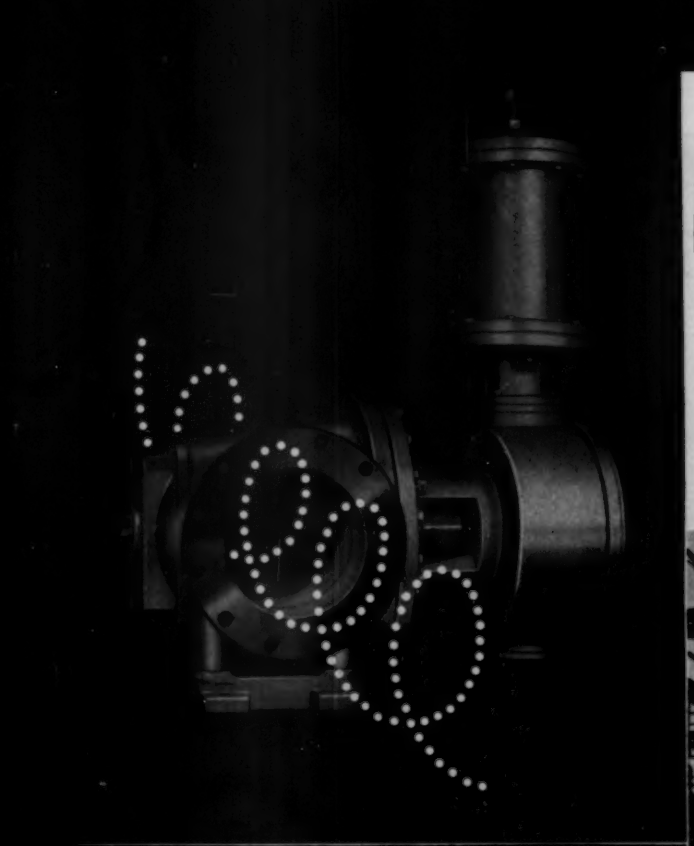
More hp in a smaller package . . . Redesign of the Allis-Chalmers hollow-shaft motor has resulted in a more compact unit. New, attractive styling makes it an asset to any pump installation. Oil-lubricated guide and thrust bearings, large accessible oil-fill holes, and easily readable oil level gauges simplify maintenance. Double end ventilation and fully guarded openings assure trouble-free service.

Control centers cut costs . . . You save space, simplify wiring and reduce inspection and maintenance expenses with new Allis-Chalmers low-voltage motor control centers. Plug-in terminal blocks and drawout construction cut inspection time by making it quick and easy to withdraw or remove control units. Pushbuttons and pilot lights are mounted on the removable frames to eliminate failures common with hinged wiring. Special connectors make it impossible for bus connections to loosen. Extra-heavy bus bracing makes additional bracing unnecessary when you add capacity.

Which of these productive ideas could be working for you?

A motor control center that simplifies maintenance. A valve that offers zero flow resistance. A more compact transformer. These examples demonstrate the extra value that is standard with A-C . . . the greater efficiency and added productivity which are yours when you buy A-C products, systems and services. Call your Allis-Chalmers representative for details on A-C "worth-more" features. Or write Allis-Chalmers, Industries Group, 904 South 70th Street, Milwaukee 1, Wisconsin.

Retrovalve is an Allis-Chalmers trademark. A-1458



"Open road" for unrestricted flow . . . This ROTOVALVE, when wide open, offers no greater resistance to flow than a straight pipe of equivalent length. Promotes lower pumping costs. Actually seats itself tighter with use. And special shut-off characteristics reduce water hammer. All moving parts are totally enclosed, yet easily accessible.

Transformers "grow up" but don't get bigger . . . New Allis-Chalmers transformers deliver as much as a 30% increase in kva without any increase in size or weight. This permits replacement of old transformers without altering base mountings or overhead structures. The unit being installed has twice the rating of the neighboring 2500-kva transformer.

Stainless steel "scorns" corrosion . . . It's standard with all Allis-Chalmers tray-type deaerator internals. This 90,000 lbs. per hour "package" unit removes oxygen and other corrosive gases besides heating boiler feedwater. Heating and distributing tray design provides greater spillage edge — extra-efficient air separating trays remove more oxygen and gases through full counterflow design. Protects boiler and associated steam and condensate equipment from corrosive attack.

ALLIS-CHALMERS PRODUCTS: Look to Allis-Chalmers for compressors; controls; coolers; crushers; earth-moving equipment; engines; generators; industrial systems; kilns; lift trucks; motors; pumps; rectifiers; screens; electrical generation and distribution equipment; tractors; transformers; unit substations; valves; water conditioning equipment.

ALLIS-CHALMERS

"We're finding Foxboro Instruments remarkably accurate, dependable, and free from maintenance"

Marin Municipal Water District San Rafael, Calif. reports

Winter rains washing mud into supply lakes posed a difficult problem for the Marin Municipal Water District. To insure best possible operation of their Bon Tempe Filtration Plant, special attention to chemical addition and filtering was imperative.

To Foxboro instruments went the job of keeping the entire operation under control. "One glance at our central Foxboro control panel, and we know the status of our whole plant," the Chief Engineer reports.

Foxboro pneumatic instruments record and control flow, level, and back wash rate for each of the four rapid sand filters, while a Foxboro Dynalog* electronic recorder continuously charts pH of the treated water.

Since the plant was started in 1959, it has run continuously under this complete Foxboro control system. It has never had a shutdown due to instrument failure.

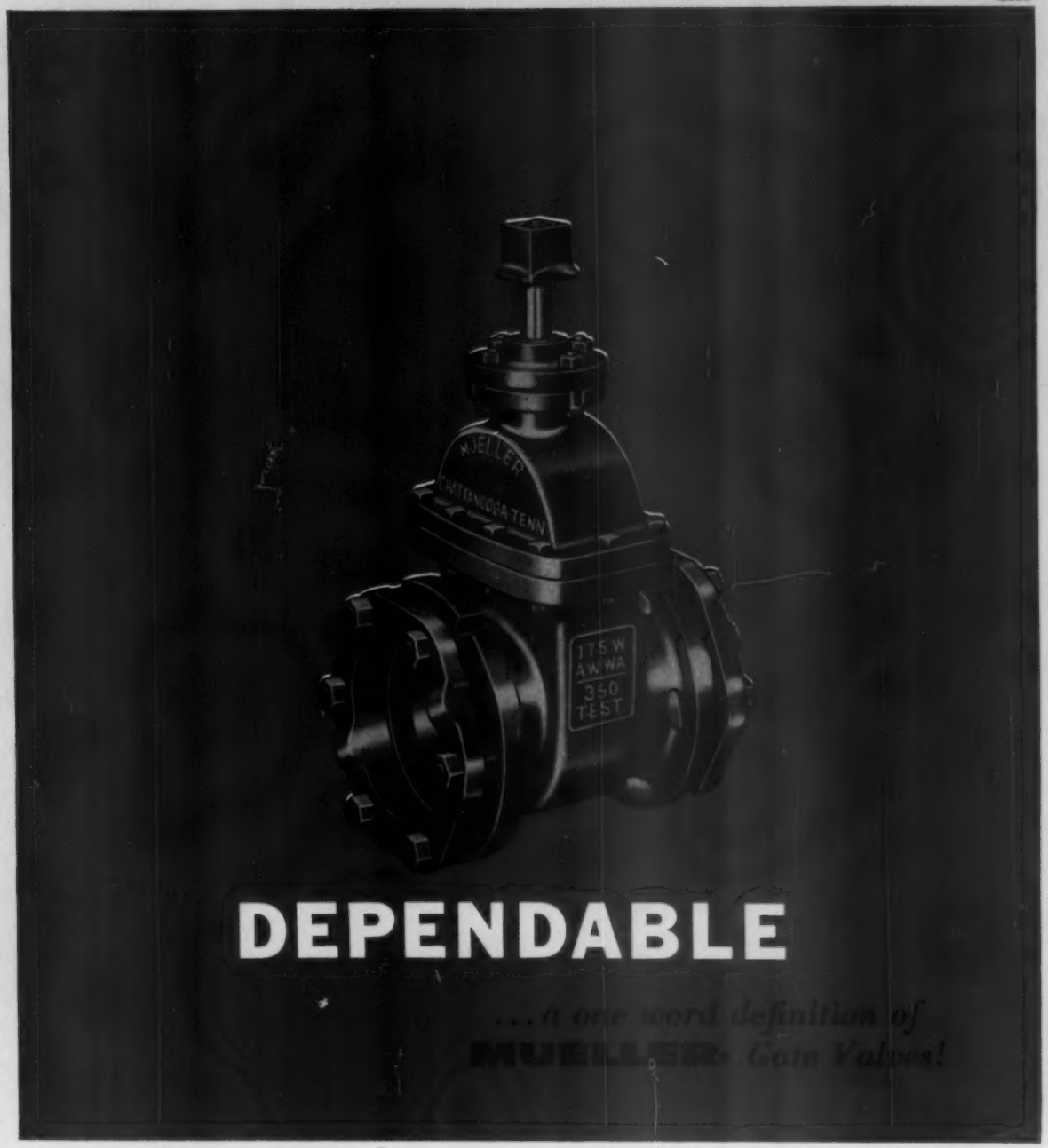
Accurate, dependable, maintenance-free — Foxboro instrumentation can help you run your plant more efficiently, too. Ask your nearby Foxboro Field Engineer to show you how. Or write for bulletin 1-15. The Foxboro Company, 896 Neponset Ave., Foxboro, Mass.

Reg. U.S. Pat. Off.

Foxboro-instrumented Bon Tempe Filtration Plant, San Rafael, California. Plant was built to serve the burgeoning population of the Marin Municipal Water District. Kennedy Engineers, San Francisco, were Consulting Engineers.

FOXBORO

REG. U. S. PAT. OFF.



DEPENDABLE

. . . a one word definition of
MUELLER *Gate Valves!*

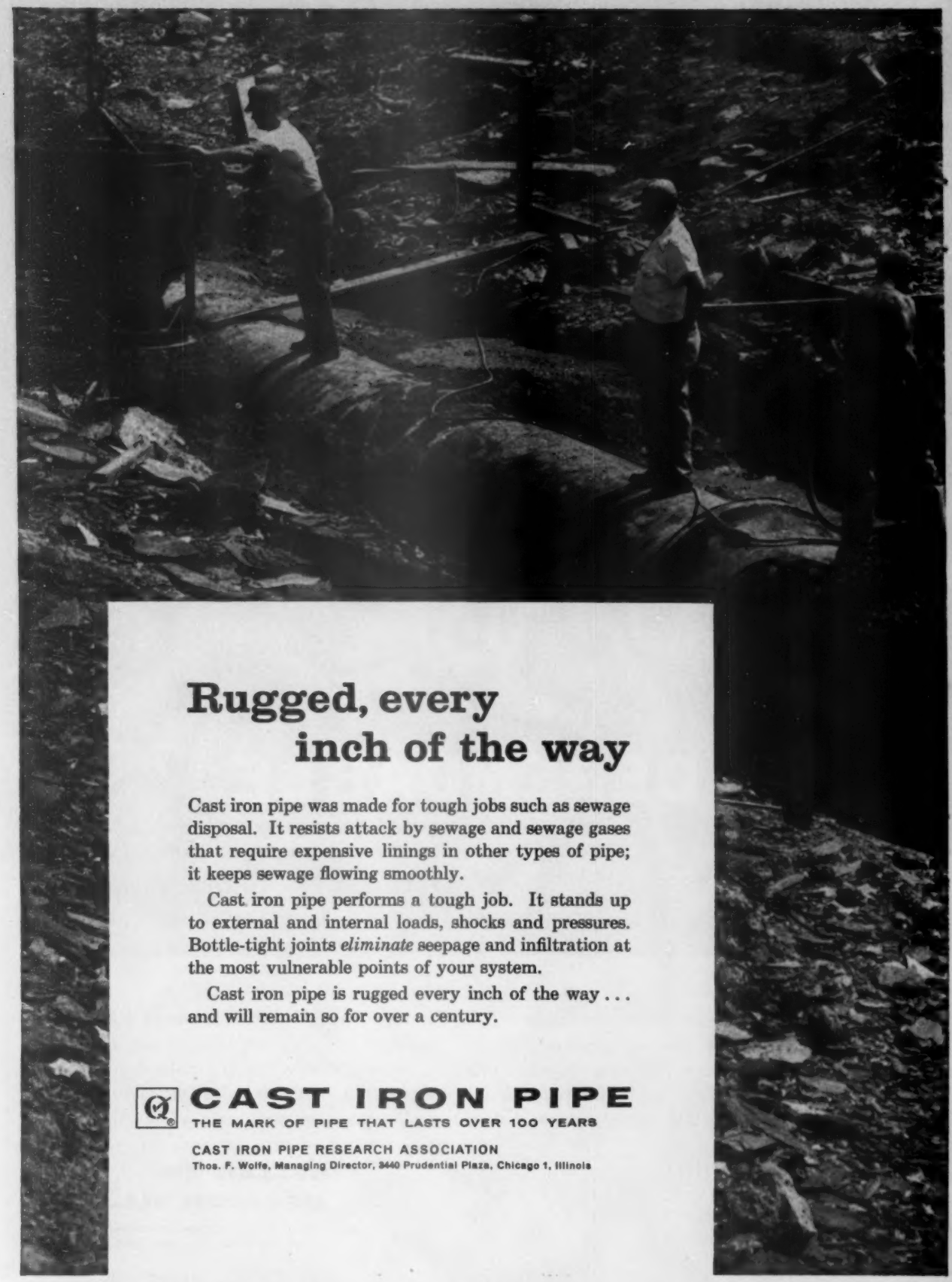
Mueller Gate Valves in your water supply or fire protection system is your assurance of years of maintenance-free service. This fact is due largely to a design-exclusive . . . Mueller's Four Point Wedging Mechanism that assures tight, sure shut-offs. This unique principle exerts equal seating pressure at four points near the edge of each disc to eliminate deflection and distortion. Write for complete information on the variety of ends and wide range of sizes on these AWWA Gate Valves.

specify Mueller . . . there is no "equal"!

MUELLER CO. since 1857 SERVING Water and Gas Industries QUALITY 5584

MUELLER CO.
DECATUR, ILL.

Factories at: Decatur, Chattanooga, Los Angeles
In Canada: Mueller, Limited, Sarnia, Ontario



Rugged, every inch of the way

Cast iron pipe was made for tough jobs such as sewage disposal. It resists attack by sewage and sewage gases that require expensive linings in other types of pipe; it keeps sewage flowing smoothly.

Cast iron pipe performs a tough job. It stands up to external and internal loads, shocks and pressures. Bottle-tight joints *eliminate* seepage and infiltration at the most vulnerable points of your system.

Cast iron pipe is rugged every inch of the way . . . and will remain so for over a century.

CAST IRON PIPE

THE MARK OF PIPE THAT LASTS OVER 100 YEARS

CAST IRON PIPE RESEARCH ASSOCIATION

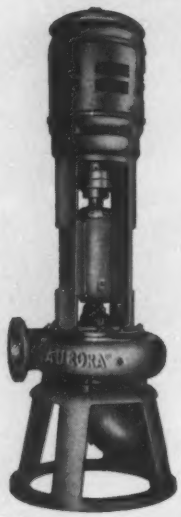
Thos. F. Wolfe, Managing Director, 3440 Prudential Plaza, Chicago 1, Illinois

OBJECTIVE PERFORMANCE

. . . EFFICIENCY AND ECONOMY WITH

AURORA® *Heavy Duty*

NON-CLOG PUMPS



TYPE KUC VERTICAL—For compact installation with flexible coupling drive...motor high above floor.

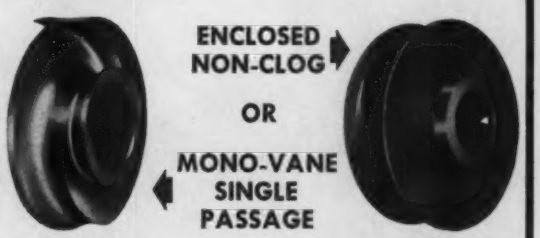
TYPE KCM VERTICAL—Utmost compactness...close-coupled design...low suction.

For handling heavy liquids . . . and solids in suspension. Ideal for public utility and industrial wastes.

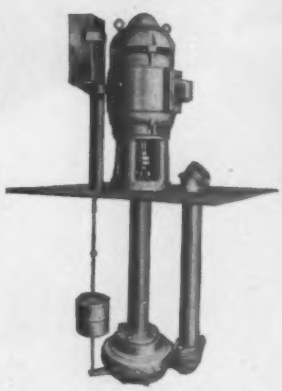
Capacities to 9000 GPM • Heads to 150 feet • Solids size to 6 inches

- Easy Installation
- Easy Disassembly
- Smooth—Quiet operation
- Hand cleanout provided in casings
- Detachable suction and packing covers
- Large Passageways
- Many optional features available
- Uniquely balanced impellers
- Engine or combination drives available
- Deep packing boxes

ALTERNATE IMPELLER DESIGN



TYPE KU VERTICAL—For flexible shaft drive...misalignment proof ...elevated motor protection against pit flooding.



TYPE KS VERTICAL SUMP—For heavy duty wet pit service. Complete unit engineered to specific pit requirements.

TYPE KGG HORIZONTAL—Rugged base mounted unit ...for use where suction conditions permit horizontal mounting.

ASK FOR...

MONO-VANE BULLETIN 121MV

NON-CLOG BULLETIN 121A

SUMP BULLETIN 104

AURORA Always PUMPS

AURORA PUMP DIVISION
THE NEW YORK AIR BRAKE COMPANY
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LOCAL DISTRIBUTOR IS LISTED IN THE YELLOW PAGES OF YOUR PHONE BOOK

THIS WORK-HORSE VALVE WILL SAVE YOU MONEY!

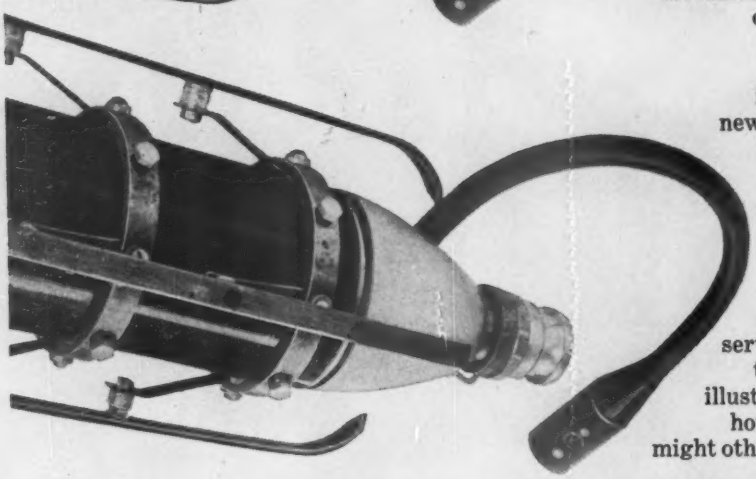
ACF Lubricated Plug Valve

You will save on purchase price and in operating costs with the ACF Lubricated Plug Valve. Thousands of others have done the same and are successfully using this versatile valve in chemical plants, sewage plants, paper mills, oil production, mining operations and steel mills . . . it's a long list of applications. A cylindrical plug — like a journal in a well-oiled bearing — can only rotate, can't wedge and can't unseat. The ACF Lubricated Plug Valve may be installed in any position, fits in the smallest possible space. It can be serviced quickly, requires little attention. The efficient lubrication system holds corrosion to a minimum. Send for Catalog 400, P. O. Box 2117, Houston 1, Texas.

WHEN SO MUCH DEPENDS ON A VALVE . . . SPECIFY W-K-M

W-K-M DIVISION

ACF INDUSTRIES



MODERN MISSILES FOR INNER SPACE

CEMENT LINING BY CENTRILINE

Just as valuable to your city's pipelines as jet engines are to airlines—this is the Centriline machine. Its job, bringing new life to small, vital transmission and distribution lines.

Specifically, a Centriline crew using this machine lines pipes of 4" to 14" diameter with a coating of cement mortar, to end tuberculation and corrosion. Other Centriline equipment revives old pipes up to twelve feet in diameter. Once cleaned and Centrilined—*in place*—carrying capacity of pipes is often greater than when they were new. Pressure goes up, pumping costs go down, and all at a fraction of the cost of laying new mains.

Over 7 million feet of pipes have been Centrilined while still underground, which goes a long way toward proving the value and economy of the process. Note also that Centriline service is complete, from initial cleaning to the final proving out. Write for our illustrated brochure which shows in detail how Centriline can help save lines that might otherwise have to be completely replaced.

CENTRILINE CORPORATION

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BOOTH 105-107 A.W.W.A. CONVENTION

IOWA Valves and Hydrants

by the carload to meet San Jose Water Works' growing requirements

Glimpse of new subdivision of San Jose, California. City has grown from 95,280 to 202,571 in past ten years.

Unloading scene as IOWA hydrants are delivered by the carload to San Jose Water Works.

Two IOWA gate valves and a new hydrant being installed. Hundreds of these Iowa products are important components of San Jose's modern system.

Carloads of IOWA gate valves and hydrants were purchased by the San Jose Water Works (an investor-owned, private company established in 1866) for installation in their rapidly expanding system which serves seven cities and unincorporated areas in Santa Clara County, California.

Over 17,000 new water service connections were made in the last two years along 1200 miles of water mains to help care for a metropolitan population (Approx. 306,000) which has doubled since 1950.

IOWA products were selected to be a part of the San Jose Water Works' growth because of their proved dependability with minimum maintenance and assurance of long-life performance.

Every year more and more IOWA valves and hydrants are installed to serve the needs of growing communities like San Jose. Experience shows that IOWA products have that extra quality of materials, that extra-precise fitting and assembly that makes for longer life and easier maintenance.

Let us send you details on the complete IOWA line

IOWA VALVE COMPANY
Oskaloosa, Iowa
Subsidiary of James B. Clow & Sons, Inc.

a CLOW Subsidiary

WHEN BUYING HYDRANTS LOOK FOR A MANUFACTURER WITH AT LEAST 100 YEARS' EXPERIENCE

Age has its advantages when you are dealing with fire hydrants, because hydrants must provide many years of reliable service. When a manufacturer has been in business 100 years or more, the quality of his product is well known.

R. D. Wood Hydrants have stood the test of time. There are more than a million of them in use right now. This says a great deal for the excellence of the product and the reliability of service.

When you deal with R. D. Wood (over 100 years in the hydrant business) you have the comfortable feeling that we will still be around when your equipment needs service or even replacement.

Conform to A.W.W.A. specifications

R. D. WOOD COMPANY

Public Ledger Bldg., Independence Square, Philadelphia 5, Pa.

Established in 1803

Manufacturers of "Sand-Spun" Pipe (centrifugally cast in sand molds)

THIS IS THE R. D. WOOD LINE

R. D. Wood Mathews Modernized Hydrant with replaceable barrel.

R. D. Wood Mathews Flange Barrel Hydrant ... dry-head construction keeps it operating in every kind of weather.

R. D. Wood Swivel Joint Hydrant can be faced in any direction.

R. D. Wood Gate Valve—bury it and forget it.

"Palletizing saved us $101.00 per carload of pipe unloaded. All pipe received in excellent condition."

MAYOR ROBERT L. HIPPS
LOVELAND, COLORADO

"This report was received from Dr. Robert G. Lanning, Chairman of the Water Committee, and Mr. Will Osborne, Superintendent," said Mayor Hipps.

The savings you achieve because of palletizing of *Griffin-20* may be more or less than the $101.00 per carload mentioned above . . . depending upon which unloading method you have previously used.

Palletized Griffin-20 pipe can be unloaded in double tiers in approximate 7-ton lots with a fork lift or with a crane; or in single tier 3½-ton palletized lots, if you prefer. Griffin-20 palletized pipe can also be skidded directly to a trailer or to the ground, without using any lift equipment.

Rest assured, your savings will be substantial. Remember that with modern 20-foot pipe lengths you will be handling and assembling 20 percent fewer joints. Griffin offers these advantages to *all* customers on *all* shipments.

GRIFFIN PIPE DIVISION
GRIFFIN WHEEL COMPANY
A Subsidiary of American Steel Foundries
Council Bluffs, Iowa

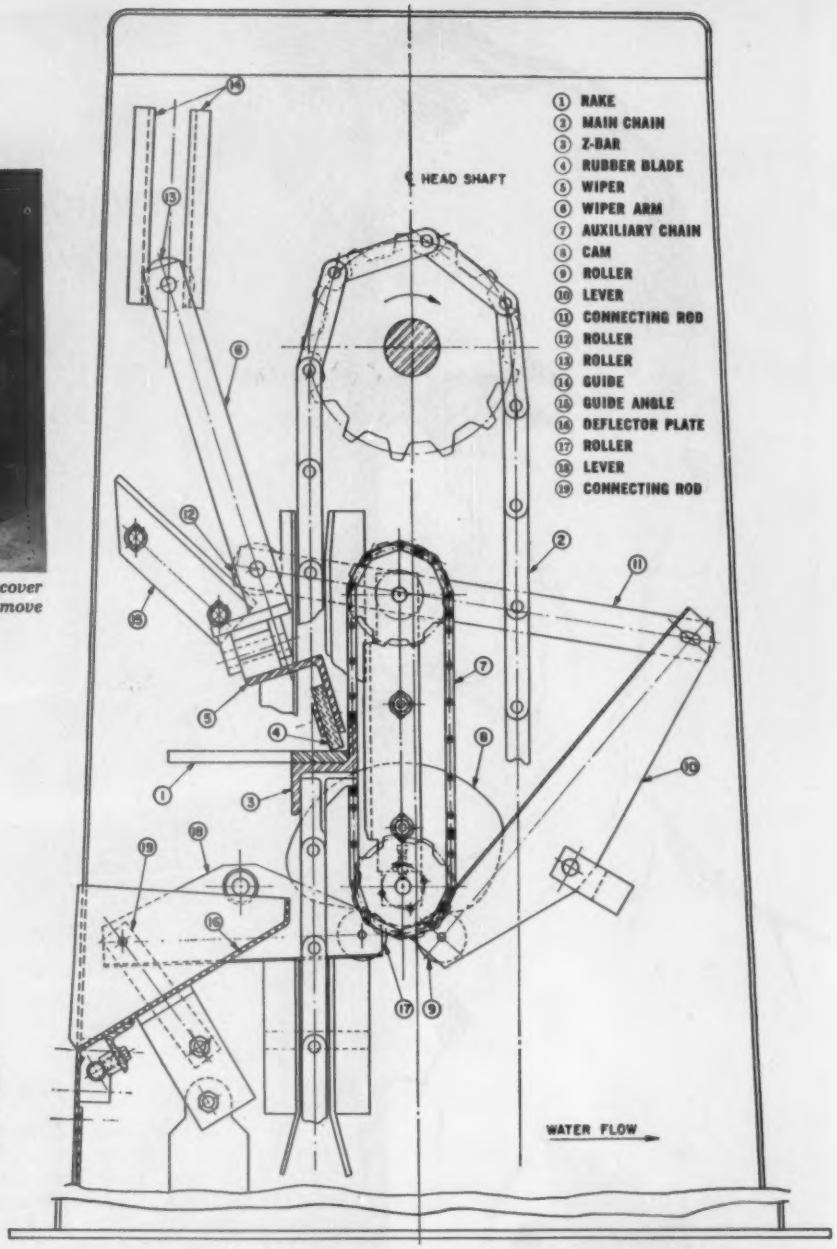
GRIFFIN PIPE DIVISION
COUNCIL BLUFFS

SALES OFFICES

CHICAGO AREA POrter 6-0452, 850 E. Green St. Bensenville, Illinois	Marvin E. Simpson, District Manager; Alex E. Kessler (E. Troy, Wis.), Sales Representative
COUNCIL BLUFFS 322-6641, 2601 Ninth Ave.	John L. Larson, Sales Representative
DENVER West 5-2427, 1400 W. Evans Avenue	John M. Masterson, District Manager
KANSAS CITY, KANSAS DRexel 1-5690, 1134 S. 12th St.	Thomas M. McGinley, Sales Representative
ST. PAUL Prospect 6-1521, 941 Johnson Pkwy	William R. Colton, District Manager; Willard F. Klimmek, Sales Representative

Vertical back-cleaned bar screen with cover removed to show traveling rakes that remove waste from screen.

Modern Jeffrey screens assure successful operation



RAKE WIPER MECHANISM FOR VERTICAL BAR SCREEN (Pat. Applied For)

The latest Jeffrey designed screens incorporate the most advanced operating techniques in back-cleaned screens. The design has been constantly improved from year to year since Jeffrey built the first practical back-cleaned screen.

The head frame has been streamlined to present an attractive housing which contains the new Jeffrey cam operated wiper and tilting tray mechanism. Moving rakes engage lugs on auxiliary chains which control the action of the cam.

The wiper is free to move on each end to insure uniform bearing of the wiper blade on the rake even when the rake is out of alignment. The entire mechanism is positive and silent.

The head frame is shipped completely assembled as shown, after it is factory tested. The boot section is also factory tested and assembled before shipment to customer.

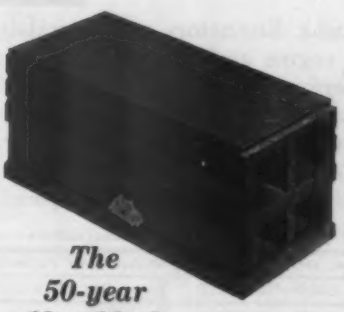
Jeffrey Sanitary Engineers offer help in adapting these screens and other Jeffrey products to water, sewage and waste recovery plants. For a copy of Bulletin 952 describing these services, write The Jeffrey Manufacturing Company, 996 North Fourth Street, Columbus 16, Ohio.

If it's conveyed, processed, or mined, it's a job for Jeffrey.

JEFFREY

LEOPOLD CONTROL PANELS AND LIFETIME BOTTOMS USED IN DETROIT'S SPRINGWELLS ADDITION

Detroit's ultra-modern 200 M.G.D. addition to the Springwells Station includes both Leopold glazed tile filter bottoms and Leopold control panels, as shown above. Leopold bottoms were used for this project as well as the 240 M.G.D. Detroit Northeast Station, where they went into operation in 1955. Leopold filter plant equipment is installed at thousands of water treatment plants throughout the country, both for new and for rehabilitation projects. You can specify an entire noncorroding filter installation from Leopold . . . including bottoms, fiberglass-reinforced wash troughs and rotary surface washers. Butterfly valves, chemical feeders, sampling devices and other treatment plant equipment is also available from Leopold. Write today for complete facts and figures.



The 50-year filter block

Leopold

F. B. LEOPOLD CO., INC., Zelienople, Pa.

Visit us at Booths 201 and 203, A. W. W. A. Convention in Detroit

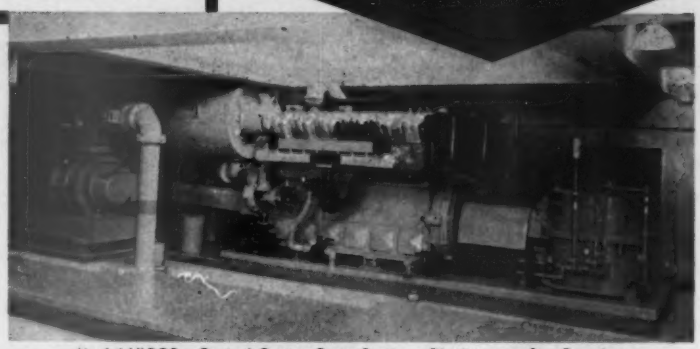
WAUKESHA POWER for MUNICIPAL PLANTS

NATURAL OR SEWAGE GAS • GASOLINE • DIESEL • LP GAS

10-1235 HP

ENGINES

Waukesha engines for water and sewage applications are available for gas or gasoline fuels or as normal or turbocharged Diesels. From this complete line select exactly the *right* engine. Materials, design, and operating characteristics are the result of over fifty years' experience in building fine engines. For honest, reliable, profitable operation, you cannot buy better engine power.



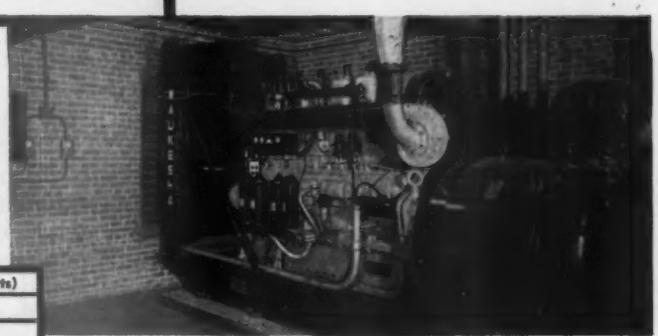
Model VLROB—Central Contra Costa Sanitary District, near San Francisco.

NATURAL GAS SEWAGE GAS LP GAS GASOLINE					DIESEL FUEL ENGINES				
Model	B & S	Cyl.	Displ.	Max. HP @ RPM	Model	B & S	Cyl.	Displ.	Max. HP @ RPM
135-GZ	4⅜x5	6	451	135 @ 2400	148-DKB	5¼x6	6	779	200 @ 2100
140-GZ	4⅜x5½	6	554	191 @ 2400	148-DKBS	5¼x6	6	779	280 @ 2100
145-GZ	5⅜x6	6	817	240 @ 2400	WAKDB	6¼x6½	6	1197	258 @ 1800
WAKC	6¼x6½	6	1197	309 @ 1800	WAKDBS	6¼x6½	6	1197	400 @ 1800
NKRB	7 x8¼	6	1905	343 @ 1200	NKDB	7 x8¼	6	1905	297 @ 1200
LRORB	8½x8½	6	2894	515 @ 1200	NKDBS	7 x8¼	6	1905	390 @ 1200
LRZB	9⅜x8½	6	3520	590 @ 1200	LRDBC	8½x8½	6	2894	415 @ 1200
VLROB	8½x8½	12	5788	980 @ 1200	LRDBCS	8½x8½	6	2894	695 @ 1200
					VLRDB	8½x8½	12	5788	905 @ 1200
					VLRDBS	8½x8½	12	5788	1235 @ 1200

Ratings shown are maximum. Continuous ratings and speeds are in Waukesha Chart 1079. *Models here* are most frequently used for municipal service. Waukesha's approximately 30 gas, gasoline and Diesel models range from 10 to over 1200 hp. Turbocharged Diesels indicated by letter "S" in table.

ENGINATORS®

Waukesha Enginators are accurately balanced engine and generator combinations that perform dependably in all applications requiring a smooth, steady flow of power for continuous, intermittent and stand-by duty. 50 to 800 KW capacities—gas, gasoline, normal or turbocharged Diesel operation.



350 KW (Model LRDBSU) Waukesha Diesel Enginator.

Approximate ratings—consult Waukesha Motor Co. for ratings applicable to your service.

MUNICIPAL ENGINATORS—CONTINUOUS DUTY RATINGS (Kilowatts)

DIESEL ENGINATOR SERIES					GAS ENGINATOR SERIES				
MODEL	60-Cycle RPM				MODEL	60-Cycle RPM			
	720	900	1200	1800		720	900	1200	1800
135-DK	NA	NA	NA 50*	60 75*	135-GZ	NA	NA	35	50
148-DK	NA	50 NA*	65 85*	100 150*	140-GZ	NA	NA	45	65
					145-GZ	NA	NA	70	100
WAKD	NA	75 120*	100 150*	125 200*†	WAKC	NA	85	110	150†
NKD	100 125*	125 150*	150 200*†	NA	NKRB	106	130	160†	NA
LRD	150 200*	185 275*	250 350*†	NA	LRORB	160	200	250†	NA
					LRZB	200	250	300†	NA
VLRD	325 400*	400 500*	500 675*†	NA	VLROB	325	400	500†	NA

NA = NOT AVAILABLE. Ratings based on standard conditions—29.92" Hg. Barometer and 60° F. Air Temperature. Ratings are maximum KW for continuous duty at sea level at speeds indicated. Gas models rated using 1000 BTU Natural Gas. For Diesel models, upper KW ratings are for naturally aspirated models, and lower ratings marked * are for turbocharged models. Ratings are for radiator cooled fan units. Higher ratings permissible with heat exchanger cooling. Higher ratings available for intermittent and stand-by service. † Consult Waukesha Motor Company stating specific applications details.

WAUKESHA MOTOR COMPANY

WAUKESHA, WISCONSIN

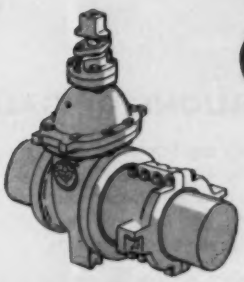
NEW YORK • TULSA • HUNTINGTON PARK, CALIF.

Factories: Waukesha, Wisconsin and Clinton, Iowa 516

GATE VALVES

CUT-IN VALVES

FIRE HYDRANTS

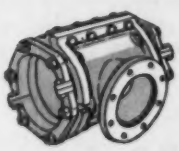


INSERTING VALVES

REPAIR SLEEVES

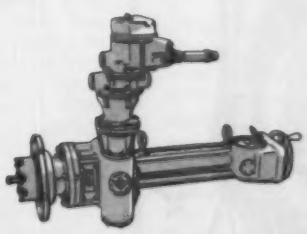
The A. P. Smith Manufacturing Company has served the water and gas utility industry for over 60 years; supplying them with a broad line of superior products including Gate Valves, Fire Hydrants, Tapping Sleeves and Valves and allied equipment.

Smith also designs and builds products for highly specialized services and operating conditions. We solicit your inquiries for standard and special design products.



TAPPING SLEEVES

TAPPING VALVES



TAPPING MACHINES

HYDRANTS — VALVES

THE A.P. SMITH MFG. CO.

— SINCE 1896 —

EAST ORANGE NEW JERSEY

BILLIONS OF GALLONS PER DAY...

Every day this great flood of water—
water for the beneficial
use of people in communities all over North
and South America—flows through
Roberts equipped plants.

Roberts equipment purifies over 5 billion
gallons daily for community
water supplies and for hundreds of
vital industrial uses.

In cooperation with engineers
and architects throughout
the Western Hemisphere Roberts Filter has devoted
itself exclusively to supplying of water
purifying equipment
for more than 60 years.

Known for its wide range of equipment—
for water filtration and softening
plants and swimming pool recirculating systems—
the Roberts name is
synonymous with quality and dependability
with engineers and architects
everywhere.

Place your water purification problems
in the hands of our
experienced and dedicated
organization.

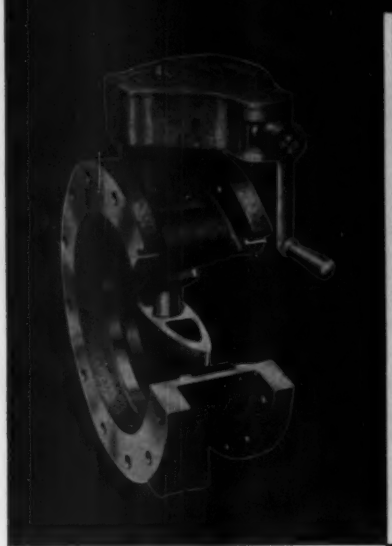
**Visit the Roberts Filter Booth 102 at
A.W.W.A. Convention June 4-9**

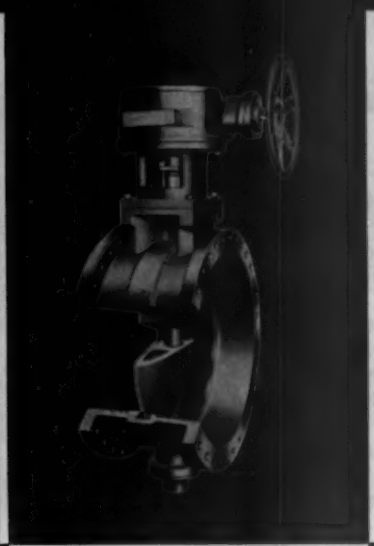
the nameplate of dependability . . .

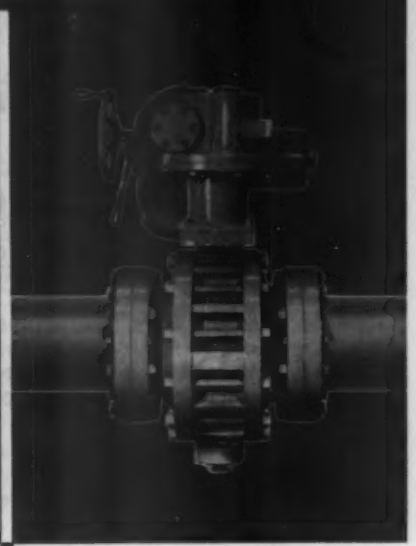
MECHANICAL EQUIPMENT
BY
ROBERTS FILTER MFG. CO.
DARBY, PENNA.

**ROBERTS FILTER MANUFACTURING COMPANY
607 COLUMBIA AVENUE, DARBY, PA.**

Now! PRATT STANDARD RUBBER SEAT VALVES FROM VACUUM TO 250 psi







150 psi Standard Valve Flanged or Monoflange

This Henry Pratt valve is loaded with extra values . . . the most *rugged construction* available . . . lower costs due to complete standardization . . . and economical *space savings* thru new narrow face-to-face dimensions in classes up to 125 psi . . . *new sidewinder operator* with manual, cylinder and motor types.

Highly versatile—available in 2 flange or monoflange types, with floor stand or extension bonnets, and completely sealed operators for buried service.

For AWWA classes 25-8 thru *125-16* in sizes 4″ thru 20″.

Write for Bulletin 6-B.

50 and 125 psi Standard Valves with adjustable seat

For the first time, 50 psi Standard Valves are available with economical narrow face-to-face dimensions thru the full 50-16 classification. The 125 psi Standard Valves in wide face-to-face offer traditional Pratt ruggedness in classes 50-8 thru 125-16. In all classes the valve seats are factory adjusted around their perimeter for the most precise fitting of disc to seat, a feature that offers:

Easier operation—with a precisely fitted seat.

Longer Life—accurate control of disc-seat interference provides tightness without wear.

Bubble-tight operation up to 150 psi.

Easy field adjustment . . . seats can be adjusted or even replaced without dismantling the valve or removing it from the line . . . and the seat fitting will be factory accurate.

Sizes 24″ thru 72″.

Described in Bulletin 6-B.

Pratt Rubber Seat Ball Valve for 150 and 250 psi

Resilient seating has now been applied to ball valves—putting the time-proved advantages of this seat to work at higher pressures and velocities than ever attained before.

The Henry Pratt Ball Valve offers bubble tight performance for ball or cone valve applications plus these definite advantages: *less weight, smaller size, lower operating torques* than similar valves . . . and *no more pressure drop than equivalent length of pipe*. The rubber seat will not bind or stick and compensates for line distortion. One man operation against full line pressure.

Complete line of operators and accessories. Ideal for buried service with enclosed operator. Sizes 10″ thru 48″.

Write for Bulletin BA-1-B.

Creative Engineering for Fluid Systems

HENRY PRATT COMPANY
319 West Van Buren Street • Chicago 7, Illinois
Representatives in Principal Cities

See us at the **AWWA Convention** *in Detroit.* **Booths 225-227-229**

HENRY PRATT®

As in most modern water supply stations

LimiTorque MOTORIZED VALVE OPERATORS

...are widely used in the new COLUMBUS, GA. RAW WATER PUMPING STATION

This modern Pumping Station, located at Columbus, Ga., gets its power from the new Oliver Dam which is located next to it . . . The Station pumps water from the Chattachoocee River up to the Filtration Plant, about one mile away . . . During the period it has been in operation, it has proved to be efficient and economical, and has met the growing demands of the area it serves.

The Pumping Equipment for this fine station was installed by Burford, Hall & Smith, well-known Power Plant Equipment firm of Atlanta, Ga.

The reasons why LimiTorque Motorized Operators are so widely used in Water & Sewage Plants (as well as most all other types of Industrial Plants) is because they are accurate, safe, convenient, long-lived, economical and absolutely dependable . . . In addition to all these attributes, LimiTorque prevents any possible damage to vital operating parts in closing, due to a unique torque limiting mechanism.

LimiTorque can be easily field-mounted on existing valves . . . and remember LimiTorque is backed by nearly 30 years experience, plus the modern facilities and reputation of one of the World's largest manufacturers of Gears and Geared Products.

For further information about LimiTorque—consult your valve manufacturer or nearest LimiTorque Sales-Engineering Office.

Send for LimiTorque Bulletin #1-60, and please use your Business letterhead when requesting.

*This Plant was designed by Robert & Company Associates, Consulting Engineers, Atlanta, Ga.

THERE IS NO SUBSTITUTE FOR —

LimiTorque®

PHILADELPHIA GEAR CORPORATION
KING OF PRUSSIA (SUBURBAN PHILADELPHIA), PA.
Offices in all Principal Cities

INDUSTRIAL GEARS & SPEED REDUCERS • LIMITORQUE VALVE CONTROLS • FLUID AGITATORS • FLEXIBLE COUPLINGS
Limitorque Corporation • King of Prussia, Penna.

YOU CAN DEPEND ON

Darling

drop-tight shutoff
maximum seat life
easy operation

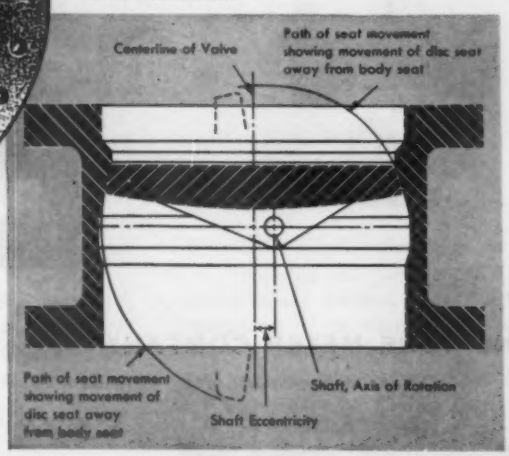
Darling-Pelton Butterfly Valves have a continuous 360° rubber sealing ring, uninterrupted by the valve shaft, that makes complete drop-tight shutoff possible. The valve disc, swinging on an axis eccentric to the valve centerline, is exceptionally easy to operate. It lifts away from the body seat on opening to eliminate any abrasion or distortion. The rubber seat can be replaced quickly without dismantling the valve. *You can depend on* Darling-Pelton Butterfly Valves for safety, long service, superior performance.

Write, wire or phone for your copy of Bulletin 5904 giving complete information on these butterfly valves made to A.W.W.A. Specifications.

DARLING VALVE & MANUFACTURING CO.
Williamsport 11, Pa.

The Canada Valve & Hydrant Co., Ltd., Brantford 7, Ontario, Canada
Vannes Darling-France, 23 rue du Commandant Mouchotte, St. Mandé, France

Exaggerated diagram showing eccentricity of valve shaft in relation to valve axis and how the disc, upon opening, is lifted from the body seat throughout its entire circumference.


Centerline of Valve
Path of seat movement showing movement of disc seat away from body seat
Path of seat movement showing movement of disc seat away from body seat
Shaft, Axis of Rotation
Shaft Eccentricity

TRADE DARLING MARK

GATE • BUTTERFLY • CHECK • SPECIAL VALVES • FIRE HYDRANTS

Bulletin

Neptune Reveals 3 Money-Saving Features of Forthcoming New Model 60 Water Meter

Here is a remarkable new meter that makes progress a pleasure – because it protects both your *present and future* meter investment.

The Model 60 has all the advantages of the most modern sealed, magnetically driven register and gear train constructions . . . in a quiet, trouble-free disc meter . . . plus three exclusive new features:

1. The register can be removed, repaired, reset to zero and resealed.
2. Meter registration can be adjusted with change gears . . . vital in reducing repair costs over the years ahead.
3. Protects against unnecessary replacement costs because you can easily repair *minor* damage without having to scrap *major* units.

Older Tridents can be converted and modernized. Both the new register and the new gear train fit standard meters, old and new.

Because of Neptune's standards and dedication to the firm policies of interchangeability and repairability, design of Model 60 has been a more difficult task, and therefore has taken a little more time.

We strongly urge you to wait and see this remarkable new Trident before you buy any sealed meters. (No need to delay your regular Trident purchases, however, because any Trident household meter you buy today can be converted later.)

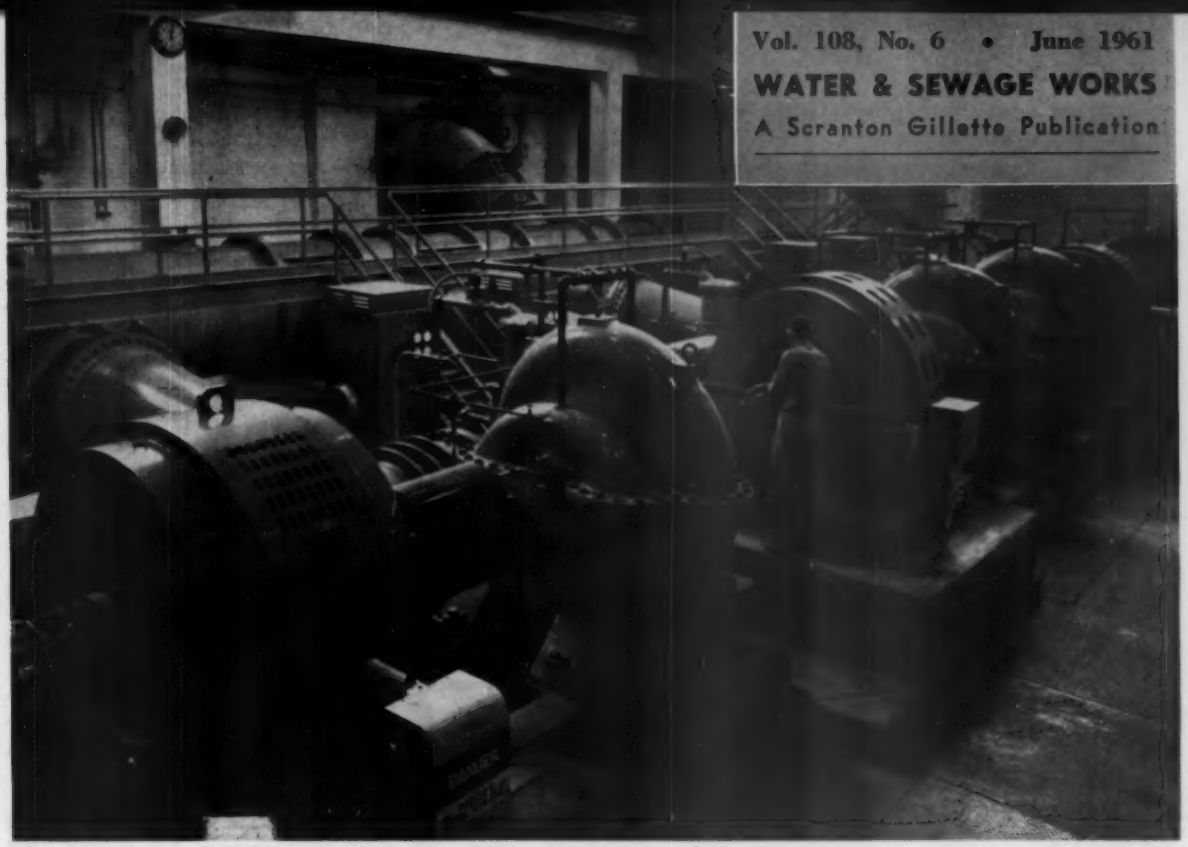
Trident Model 60 is coming soon . . . watch this magazine for full details.

neptune
TRIDENT WATER METERS

NEPTUNE METER COMPANY • LIQUID METER DIVISION • *47-25 34th St., Long Island City 1, N. Y.*

Offices in Principal Cities • In Canada: Neptune Meters Ltd., 1430 Lakeshore Rd., Toronto 14, Ont.

Vol. 108, No. 6 • June 1961
WATER & SEWAGE WORKS
A Scranton Gillette Publication



THESE NEW electric pumps are replacing steam pumps that have been in use at Water Works Park Station for over three generations. Electrification of the 84-year-old plant is part of the Detroit Water Board's modernization program.

AWWA VISITS DYNAMIC DETROIT

■ WHEN THE MEMBERS of the American Water Works Association convene in Detroit from June 4 to 9, they will see a city that is literally being reborn.

Cobo Hall and Convention Arena, the 54-million dollar facilities that will house the convention, and the surrounding Civic Center are striking symbols of an all-out effort Detroit is making to meet the new challenges of 20th century metropolitan life.

Since the day it started putting the world on wheels, Detroit has been in the vanguard of industrial, commercial and educational progress. Today's municipal leaders are determined that the city will maintain the pace, and they have committed all the resources at their command toward that end.

Because modern urban life changes so rapidly, a city must be truly dynamic to survive. Today's problems and needs are often totally different from yesterday's and they demand totally new solutions. If a city is to keep pace with the times, it must adapt itself to new challenges and be prepared with new ways to meet them.

This requires new ideas, programs, and facilities in some areas, renewal in other areas, and renewed effort along established lines in still other areas.

COVER PHOTO—Detroit's Springwells Station, one of the world's largest water treatment and pumping plants. Located on a 53 acre site, the plant will filter a maximum of 540 mgd.

by GERALD J. REMUS
General Manager
Detroit Dept. of Water Supply

Detroit is moving forward in all three directions, and nowhere is this progress more evident than in the development of its water supply and sewage disposal systems.

In this field we are confronted with two broad problems that are

common to many metropolitan regions throughout the nation.

The first of these is the need to maintain the adequate, reliable water supply and sewage disposal service that Detroiters have enjoyed for decades. The factors involved in maintaining that service lead directly into the second problem, the need to expand our system to serve a growing number of suburban communities.

I am sure no explanation is required on my part to explain to people in the water works field the need for modernization of plants and equipment. Daily wear and tear and rapid technological advances make a program of continual modernization imperative for any major system.

Added to this need for capital improvement in Detroit is an urgent need to increase the system's basic reliability. This need stems from the fact that the entire water system, complex as it is, still depends upon a single raw water source, the Detroit River. Because of vulnerability to enemy attack, this dependence upon a single source has long been considered undesirable by local defense and water supply officials. In recent years this undesirability has been compounded by increasing pollution of the river from various sources.

Responsible officials have advocated for some time the location of new intake facilities in Lake Huron. This need has now reached the critical stage.

Detroit now enjoys the lowest water and sewage rates of any major system in the United States, according to several independent surveys. If Detroit were to bear alone the entire cost of system modernization and the construction of Lake Huron facilities, those rates would have to be substantially increased.

Higher Rates or More Customers

The simplest, most effective way to meet the city's needs without losing the favorable rate levels is to broaden the system's revenue base by continually increasing the number of customers.

Any substantial increase in customers must be achieved through expansion of the system to serve more and more of the surrounding suburban area.

This basic idea was recognized by the Detroit Board of Water Commissioners as early as 1924 when the Board adopted the concept of Detroit as a central supplier for the three-county metropolitan area.

Today the Water Board and the Department of Water Supply are in the midst of a 300-million dollar development program that is the largest manifestation of that basic concept undertaken to date. Over $100 million has been spent since 1950, and another $200 million is scheduled to be spent by 1980.

THIS SYSTEM CONTROL CENTER in the Detroit Water Department's main office is a tremendous aid in the operation of a widespread metropolitan system. The dials and gauges give readings of pressures and flow at checkpoints throughout the transmission system. The system supervisor is in constant radio and telephone communication with the control rooms at the plants and the maintenance headquarters.

Before this program could get into high gear it was necessary to convince large numbers of suburban officials that the best interests of their communities would be served by joining the Detroit system. Our proposals to these officials were based on two basic facts of modern metropolitan life.

The first of these is the phenomenal growth of all suburban communities. To accommodate and further this growth, suburban areas must have an adequate water supply and an effective sewerage system. Delay in constructing such systems results in incalculable costs to the community.

Second is the fact that a large system with existing capital facilities can expand to serve its suburban customers more quickly, efficiently and at less cost than suburbs can build their own facilities.

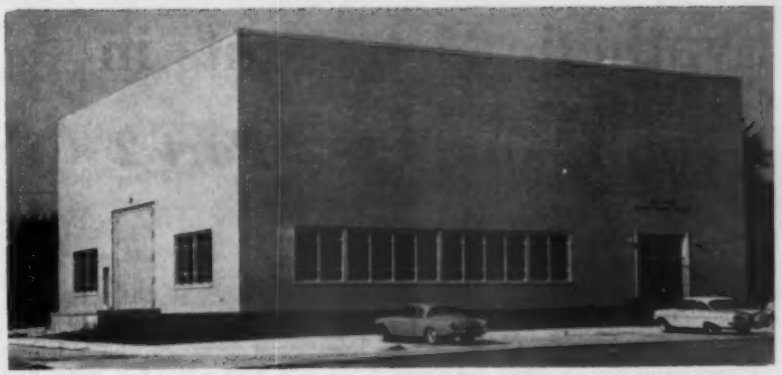
Initially suburban officials were extremely cautious in accepting these facts and the development program based upon them. This caution is only proper on the part of men charged with protecting the interests of their communities.

To convince these officials of the wisdom of our program, the Water Department developed detailed plans and proposals backed up by thorough engineering and economic studies. Equipped with these the water commissioners with the active support and assistance of Mayor Louis C. Miriani put on a concentrated drive to secure approval and commitments from officials throughout the area composed of Wayne, Oakland, Macomb, St. Clair, Washtenaw and Monroe counties.

That drive has resulted in almost unanimous approval of the Detroit program. Today, the Detroit Water Department is furnishing water to 50 suburban communities and contracts are being negotiated with a dozen more. Our sewage disposal service is purchased by 47 suburbs with more joining the system each year.

At present we are the sole, central supplier for a 400-square mile area with a population of approximately 3,100,000. By 1980 we expect to be serving between six and seven million people.

To provide adequate, reliable service we are spending at the rate of $10 million per year to modernize and expand a system that we believe is already one of the world's finest.



THE SAME expansion program that expanded Springwells Station to its present size included construction of this raw water booster station. With the booster in operation the entire raw water tunnel is pressurized giving it a capacity of over one billion gallons per day.

Present Facilities and Future Plans

Our existing water facilities include three complete pumping and treatment plants that have a combined maximum filtration capacity of over one billion gallons per day. A fourth plant is now being constructed and will be ready for service by 1963.

The long-sought Lake Huron facilities are now in the design stage, and our present schedule calls for completion of a Lake Huron intake, a treatment and pumping plant, and transmission lines to Detroit by 1967. This first section of the facilities will have a 250 mgd capacity and will cost approximately $82 million. The plant is being designed so that additional sections can be added in subsequent years.

While we move ahead on new construction at maximum rate, we are also modernizing existing facilities. We have recently completed a 35-million dollar program that expanded our Springwells plant, now one of the world's largest, and constructed a raw water booster station that allows us to pressurize the entire raw water system whenever necessary. We are currently converting the 84-year old Water Works Park Station from steam to electric pumping, and our modernization projects include replacement of many key transmission mains in the city.

To fulfill our commitments to suburban customers, the Water Board is spending about five million dollars per year for suburban transmission mains and storage facilities. We are not only meeting our commitments, but we are well ahead of all schedules.

This same pace is being maintained in the expansion of our sewage treatment plant where we are well along on a 33-million dollar program.

Our progress to date has led an increasing number of communities to become interested in joining the Detroit system. Negotiations are now in progress with communities that were not even included in the development program as it was originally announced in 1959.

Suburbs Represented on Water Board

The Water Board welcomes these extensions of the original plan and is pledged to cooperate in every possible way with prospective suburban customers. To accentuate this attitude on the Board's part, it is fitting to point out that the seven-member Detroit Water Board now includes three commissioners who are n o t residents of Detroit. They were appointed to represent our suburban customers under a charter amendment approved by Detroit voters in 1960.

In the final analysis, the development plans and progress of the Detroit metropolitan water supply and sewage disposal systems offer dramatic proof that water and sewage problems are area-wide problems. They demand area-wide, centrally coordinated solutions.

Detroit is totally committed to that philosophy, and we believe we are putting the philosophy into effect with maximum effectiveness and benefits for the entire metropolitan area.

Synthetic Detergents in Ground Waters—*Part 2*

by LOUIS G. CAMPENNI, P.E.*
FHA Zone Engineer
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Latest Moves by the County Health Department

In October, 1959, the County Health Department increased its restrictions on maximum plot densities for subdivisions with both individual water and sewage disposal systems on the same lot. It now requires a minimum lot size of 20,000 sq ft, in lieu of its former requirement for maximum plot density of two houses per acre. Under the latter requirement, lots of less than 20,000 sq ft could still qualify since the plot density basis included streets, parks, etc. The Health Department minimum lot size requirement for subdivisions now checks with the FHA field office requirement, although the FHA field office only accepts such lots on an individual, non-subdivision basis. The Health Department has also indicated that they are going to increase the minimum separating distance between individual well and sewage disposal system to 100 ft in all cases, without exceptions. The increase in minimum separating distances will then check with the minimum FHA field office requirements. (However, it should be mentioned that the FHA field office has increased its minimum separating distance between individual well and double-cesspool system to 150 ft).

A Typical Case Involving Syndet Pollution

Finally, it may be of interest to illustrate a case history on record in the County involving syndet pollution. A tenant complained of severe sewage odors, tastes, and foaming of the water supply at the tap, and finally moved out of the house because of concern for her child. The individual well supplying the house was 32 ft deep, and it was located 27 ft from the cesspool on the property. Analysis of the water revealed a syndet concentration of 4.8 ppm.

To correct the situation, the property owner deepened the well from 32 ft to 46 ft. However, syndets in greater amounts were found, at 5.3 ppm concentration. The well was then deepened to 65 ft, and the cesspool relocated from its original distance of 27 ft, to a new distance of 75 ft. Syndets were found to still be high, since tests revealed a concentration of 3.8 ppm. The well was then deepened, further, from 65 ft to a new depth of 76 ft. However, syndets were found at even a higher concentration of 4.9 ppm.

Lastly, the owner reduced the well depth back to 34 ft, with the cesspool remaining at the increased distance from the original 27 ft, to the new 75 ft distance, and the syndets were found at the lowest concentration, with tests revealing only 0.5 ppm.

In this particular case, the increased separating distance between the well and the individual sewage disposal system proved to be the relieving factor, with the increase in well depth actually worsening the problem. It is significant to note, that if the owner did not have sufficient room to relocate the sewage disposal system, a solution could not have been reached. Although the solution reached relieved the problem at the time, it can only be considered as temporary in nature, since syndets have shown a breakthrough even at the altered locations, although light in nature at the time. The case does illustrate, however, the need for sufficient lot space to provide at least temporary relief.

Unfortunately, increasing the separating distance is not always the answer, since well deepening in other cases may be necessary.

Upon receipt of information from the FHA field office in Providence, Rhode Island, and from the Rhode Island State Department of Health, the FHA sanitary engineer investigated the problem of syndet pollution in the town of Portsmouth, Rhode Island.

A 50-house development, built up slowly, and over a period of several years, was located in the town of Portsmouth, Rhode Island, in the County of Newport. Lots were typically sized from 7,000 sq ft to 12,000 sq ft, and served by individual drilled wells ranging in depth from 100 ft to 300 ft. Each lot was also served by individual sewage disposal systems of the septic tank and disposal field type, and located from 30 to 150 ft from the well systems, with an average of 75 ft.

Geology

Subsurface soil conditions included a thin mantle of glacial till composed of fairly impermeable sandy-clay, with shaley, carboniferous rock at about 10 ft depth. Ground water levels were usually at 10-15 ft depth, but fluctuated widely on a seasonal basis. The water-bearing character of the underlying rock was poor, a characteristic which is prevalent throughout the County.

Discovery of the Syndet Problem

Actually, the syndet pollution of individual wells in this development had been occurring since 1957 or possibly before, but complaints from the residents brought about a detailed investigation by the State Health Department in early 1959. The State Health Department tested half of the wells (25) and found that all but one had syndet pollution, ranging from 0.15 to 5.0 ppm. The well with the highest concentration of syndets was 250 ft deep. Nitrates were found in high con-

*Based on a talk presented before the 1960 Home Sewage and Waste Disposal Conference, Michigan State University, East Lansing, Michigan.

centrations, ranging up to 20 ppm. Six of the wells were also found to be bacteriologically contaminated. This included the one well showing no apparent evidence of syndet pollution.

Including these data in a report dated June 17-18, 1959, the Rhode Island State Department of Health reported as follows:

1. Seventy-two well waters in various parts of the State have shown evidences of syndet pollution. 56 per cent of the wells showed bacterial contamination. One-fifth of the wells were driven and one-third were drilled. 73 per cent of the wells were within 50 ft of the sewage disposal unit, and 94 per cent were within 100 ft. More than half were tested because of taste, odor, and foaming complaints with the majority of complaints being tastes and odors.
2. Syndets are very stable, travel appreciable distances through the ground and into the water table and move with the water table. (This confirmed the Long Island findings).
3. Foaming will generally appear at 0.5 to 0.6 ppm.
4. Wells are considered to be polluted or a pollution potential exists because of the presence of syndets.

Findings by FHA Sanitary Engineer

In December, 1959, the FHA Sanitary Engineer visited the site and picked up samples of water from the taps of 13 houses scattered throughout the area. Six of the samples foamed upon shaking the sample, indicating rather high concentrations of syndets. Odors were light, but where perceived, exhibited perfumey, fish-like odors. In some cases, the water foamed considerably at the tap.

A temporary steel water tank had been put in one of the streets to provide emergency water supply from other sources. The fire department maintained it, but it was grossly inadequate for the purpose. Many residents were purchasing bottled water from a street vendor at $0.85 per gallon. A number of home owners had put their houses on the market but could find no buyers. The FHA field office would not accept houses in the development for mortgage insurance purposes.

A conference at the State Health Department between the FHA Sanitary Engineer, the State Chemist who conducted the survey, and Health Department Engineers, revealed that since the Health Department's detailed investigation and report of June, 1959, additional wells in the development showed evidence of syndet-pollution, and that additional wells showed bacterial contamination. The Health Department considered wells with syndet pollution as being potentially unsafe, and so advised the residents upon their inquiry.

Corrective Measures by Town of Portsmouth

In August, 1959, the Town of Portsmouth set up new provisions governing the acceptability of both individual wells and sewage disposal systems on the same lot. The Town increased the minimum permissible lot size to 20,000 sq ft, increased the minimum separating distance between well and sewage disposal system to 100 ft, and issued special, detailed well casing requirements to be imposed under Town supervision.

In November, 1959, the Town of Portsmouth applied to the FHA "Community Facilities Administration" for funds to be used for the planning of a public water supply system for the entire town, including this affected development. The estimated cost of the water system was $1,600,000. The Town, at present, has two very small community water systems, in opposite parts of the town, and extension of such facilities to the affected development is excluded because of the 2 to 3 miles distance involved. No immediate relief for the development is foreseen.

Rhode Island State Department of Health Requirements

The Rhode Island State Department of Health subdivision recommendations of 1957 state that where individual well-water systems and individual sewage disposal systems on the same lot are proposed, that:

1. Where drilled wells and septic tank absorption field systems are proposed, the minimum sized lot should be at least 2 acres.
2. Where drilled wells and septic tanks and seepage pits are proposed, the minimum sized lot should be at least 3 acres.
3. The minimum separating distance from any well to any sewage disposal system should be at least 100 ft.

Since the FHA field office requires State Department of Health approval of all subdivisions, it has therefore, not accepted any Rhode Island subdivisions with both individual wells and sewage disposal systems since 1957.

FHA Control Measures Regarding Acceptability of Wells

Based upon the syndet problems mentioned by the State Health Department and evidence that it is a general State-wide problem, the FHA field office set up in December, 1959, a new set of requirements based on its sanitary engineer's advice. They are:

1. No subdivisions with wells and individual sewage disposal systems would be accepted unless compliance with the minimum State Health Department restrictive lot sizes is provided. (This virtually ruled out subdivisions).
2. Only those lots in remote, rural type areas would be considered. Any lots which had been located in a subdivision previously rejected under paragraph 1 above, or in an area subject to high-density build-up would be rejected even though being applied for on a non-subdivision, piecemeal basis. This would prevent subterfuging of FHA basic policy on the subject.
3. Individual lot size must be 20,000 square feet.
4. All well construction must be certified to by a licensed well-driller.
5. Each well application, where an individual sewage disposal on the same lot was proposed or exists must be studied individually as to distance of nearest public water main, feasibility of extension, etc.
6. A proposed well or existing well which shows evidence of syndets would be unacceptable.

Other Information Pertaining to the Syndet Problem

Johnson National Well Drillers Journal, November-December 1959

Page 3 of this Journal says the acceptability of a water-bearing stratum in limestone or similar creviced or fractured formations should be dependent upon the existence of at least 40 ft of overburden of unconsolidated materials which extends ½ mile in all directions from the well site. The well must also be sealed into the rock. (This 40 ft recommendation coincided with the 40 ft protective layer required by the FHA field office in Jamaica, New York, where individual wells are proposed to be driven through the usual sand and gravel formations overlying the water table). The Journal, however, made no mention with respect to this 40 ft recommendation as to the protection afforded, if any, against possible syndet pollution.

The Johnson Journal points out on page 5 that tests made in California (re: "Report on the Investigation of Travel of Pollution", State of California Pub. #11, 1954) revealed that pollution travels farthest and most rapidly in the direction of ground water flow and that chemical pollutants travel much f a r t h e r through sand than do bacterial pollutants. It also revealed that coliform bacteria were found up to 100 ft from injection wells, with diminishment of concentration upon greater distance from the source of pollution. The article states, however, that the injected polluted water used in the tests contained little or no syndets and that it is unknown whether detergents would have helped bacterial pollutions to move greater distances from the injection well.

Also on page 5 the Journal states that detergents used for dishwashing, cleaning, and laundering are chemical contaminants and that sewage digestion and percolation through the ground water remove only part of the detergents from waste water. It states that it appears that once the detergent reaches the ground water reservoir, that it will continue unchanged for quite a long time.

On page 6 mention is made of the contamination of water-bearing strata which has been discovered in the suburban developments around St. Paul and Minneapolis, Minnesota. The source is from sewage seepage into the ground waters, originating from cesspools, septic tanks and drain fields. The Journal states that the Minnesota Health Department has tested the well-water supplies and found syndets and higher-than-normal nitrates in 31 to 83 per cent of the samples tested. Although, it is stated, the chemical evidence of pollution has been found more often than bacterial pollution, it is clear that sewage is recirculating back into the drinking water supplies and this is a warning flag.

New York State Health Department, Dutchess County Health Department

Discussions with engineers from these health authorities have revealed an increased interest in the syndet problem. In the Dutchess County, New York area, a development with individual wells drilled into a stratum of limestone was found to contain syndets and some bacterial pollution. To the north of Albany, New York, it is reported that in a section encompassing some 300 homes 24 of 26 tested individual wells showed the presence of syndets. This latter area contained a porous sand and gravelly subsoil with ground water within 20 ft of grade. Both of the above areas were of course served by individual sewage disposal systems. The State Department of Health has indicated active plans to study the problem.

U. S. Geological Survey, Water Resources Division, Department of Interior

This Agency conducted a preliminary reconnaissance study of the role of anionic surfactants in ground water for the Federal Housing Administration in May, 1959. Areas in six states in the Midwestern, Southern and Western states were checked, and evidences of syndet pollution were encountered to varying degrees. Among the findings tentatively advanced were that nitrates were found in many cases along with the syndets. Significant factors related to the syndet pollution problem include the effect of separating distance between well and sewage disposal system, depth of well, direction of ground water flow, concentration of syndets discharged into the area, etc. Further studies are continuing.

United States Public Health Service

The October 1959 edition of the Journal of the American Water Works Association states that the U.S.PHS is studying the ground water contamination problem. In a New York newspaper, dated December 29, 1959, a representative of the Division of Water Supply and Pollution Control, U.S.PHS, reportedly stated that our drinking water is being polluted by hundreds of new chemicals whose affect on human health are totally unknown. Detergents are reported among these chemicals.

Journal of American Water Works Association, October 1959 Edition

An article was published entitled "Effects of Syndets on Water Supplies, Task Group Report," and discusses the high resistance to biochemical degradation of ABS and other surfactants. It is stated that detergent manufacturers are studying the possible use of a material in syndets less resistant to biochemical action without reduction in the basic syndet qualities. A change to a less resistant substitute will not be easy, however, since ABS is produced on a scale reported in 1956 to be at least 455 million pounds.

Summary of Findings and Conclusions

From the information discussed herein, some of the findings and conclusions can be summarized as follows:

Syndets represent a growing problem relative to the palatability of ground water supplies. There is little, if any, significant data available relating to the toxicity of syndets and studies are under way on this matter.

Where syndets are found in individual well systems on lots also served by individual sewage disposal systems, experience has indicated that frequently the chemical analysis of the water supply also reveals abnormal concentrations of chemicals usually associated with sewage. The syndet therefore acts as an effective tracer for the confirmation of sewage seepage into ground water. In some areas it has been found that after the initial presence of syndets, bacterial pollution enters the picture in increasing amounts.

The syndet is highly resistant to biochemical degradation, in contrast

to soaps which are much less resistant and of higher organic nature. This high resistance of syndets plays a major factor in the high buildup of syndets in a syndet-polluted ground water. Retesting of syndet-polluted water supplies has shown in many instances that the syndet concentration increases with time.

Evidences of syndet pollution have been found in various types of subsoils, ranging from fractured rock to sands and gravels. In Long Island, they have been encountered in water wells with water tables to 44 ft depths and sand and gravel soils. In Rhode Island and Dutchess County, New York, syndet has been found in limestone and shalely rock formations. Other evidences of syndet pollution have been found in many parts of the country.

The syndet, like many other chemical pollutants can travel extensively both horizontally and vertically without being broken down. They have been traced at least 95 ft deep and 1,000 ft horizontally from the source.

Direction of ground water flow is significant in the possibility of syndet pollution, since syndets travel much more rapidly once they enter the ground water. However, in large housing developments having limited lot space available it is usually impossible to locate wells such that septic tank effluent does not discharge into the ground water en route to the well. The provision of a deep soil barrier above the ground water should provide reasonably good protection against bacterial pollution, but is only a time-delay against the eventual pollution by syndets as far as experience to date reveals. In Long Island a 40 ft soil barrier is required as a minimum by the FHA field office, but this is based upon lack of evidence of significant syndet pollution at that depth to date.

As suggested by some authorities, the existence of an impermeable soil barrier above the water bearing stratum and below the point of individual sewage disposal discharge should be reasonably effective against bacterial and syndet pollution. However, the necessity for proper casing and sealing of this casing into the impermeable stratum requires unusual supervision of well-drilling operations and skilled installation. It also requires a good knowledge of the extent and character of the impermeable stratum. Unfortunately, licensing of well-drillers, adequate supervision by health, local municipal, and Federal authorities is limited and difficult to obtain.

Plot density is an important factor in controlling the effects of syndet and/or bacterial pollution. It is important to decrease the syndet concentration, give the home owner recourse to relocation of his well or individual sewage disposal system in case of pollution from his own sewage system or his neighbor's, and to obtain maximum protective separating distances.

Syndets have been found to cause foaming, tastes and odors in well-water supplies at concentrations from 1.0 to 1.5 ppm and higher. The simple "shake test" of suspect samples can reveal foaming characteristics and can prove of some value in general surveys of the problem.

The FHA field offices in Jamaica, New York, and Providence, Rhode Island, have taken very definite steps to meet the problem. Residential developments involving both individual sewage disposal systems and wells on the same lots are not acceptable, and community water supply systems or extension to public water systems are required for FHA mortgage insurance purposes in those areas. Individual lot applications in non-development areas are considered but only under specified requirements which evidence has indicated will provide maximum protection to the wells from both a bacterial and chemical viewpoint. The evidence of syndets is considered as indicating an unacceptable well-water supply. Other Federal Housing Administration Insuring Offices in the New York-New England area have virtually ceased consideration of developments with both individual wells and sewage disposal systems and have greatly limited further consideration of non-development lots with such facilities.

The cooperation of the Health Authorities is essential, and my experience has definitely indicated that where this cooperation is obtained, the combined efforts of the FHA and Health Authority has produced successful results in the installation of public and community water supply facilities to serve the homeowners. Because of long-term factors and others which involve considerations in addition to public health protection, FHA field offices in the New York-New England area have imposed restrictions on lots involving wells and individual sewage disposal systems which are far greater than those of the Health Authorities. An immediate, aggressive, constructive and direct approach by the Health Authorities, Federal and local agencies is needed now more than ever before to provide the maximum protection to the ground water supplies and to the nation's ground water resources.

AWWA Publishes Manual Dealing With Aquatic Animals

The AWWA has recently published and distributed a manual entitled, "Animals Associated With Potable Water Supplies." The booklet is designed to permit water supply personnel to acquaint themselves with aquatic animals which they may find in connection with their work.

The animals dealt with in the publication are not presently associated with human diseases. They do cause nuisances, however, because of their great abundance in raw water sources, water treatment installations or finished water reservoirs or distribution systems, according to the authors.

Grand Rapids Sewage Treatment Works Annual Report

Costs during 1959-1960 for the Grand Rapids, Mich., Sewage Treatment Works amounted to $42,770.18 for pumping; $287,055.78 for treatment; and $4,709.80 for fertilizer manufacture, making the total cost of operation $334,535.76.

According to the Grand Rapids Sewage Treatment Works Annual Report for 1959-1960, the plant has operated successfully with no serious problems resulting from industrial wastes.

It developed, the report states, that the most economical disposal of digested sludge resulted from the use of sand drying beds from April through September and the use of vacuum filters the other six months.

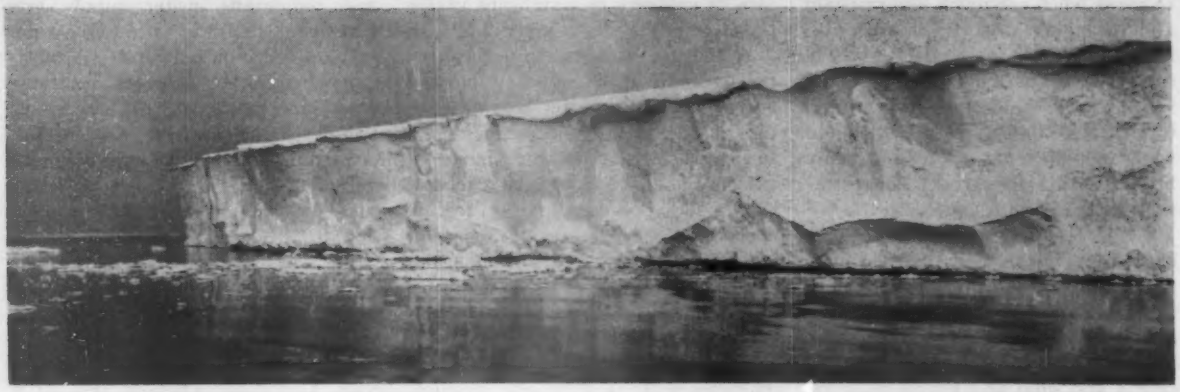

Fig. 1. ICE BARRIER at Kainan Bay, Antarctica. Official U.S. Navy photograph

Gondolas In New York?

by JOHN A. DAY, Assoc. Prof. of Physics, Linfield College McMinnville, Oregon

■ SOME ENTREPRENEUR, wishing to establish a profitable venture for his children's children might well consider the manufacture of gondolas for use in New York and other seacoast cities. For it is a scientific possibility that, sometime in the years to come, the ocean levels will have risen by such appreciable amounts gondolas, if not arks, will be needed.

This is not something that will happen in 1961, or perhaps even in 2061, so there is no immediate cause for alarm. By the time the gondolas are needed in New York, atomic power plants probably will have long since become standard gondola propulsion equipment.

What gives rise to such predictions? There are two facts. One is that the earth's atmosphere shows a very slow, but rather pronounced, warming trend. This is reflected in changes of climate. Arctic climates are now giving way to sub-arctic conditions. Regions which half a century ago experienced severe, long winters now have climates which will sustain types of agriculture requiring longer growing periods. Glaciers are retreating and the area covered by floating Arctic ice is shrinking. Temperatures at Little America, in the Antarctic, average about five degrees warmer now than 45 years ago. Certain types of marine life which avoid cold ocean waters are being found in higher latitudes. Sharks now menace bathers as far north as San Francisco. Barracuda are observed off the Washington coast.

The other fact is that explorations of the polar regions have disclosed that much greater than previously suspected amounts of water are locked up at the poles, particularly at the South Pole. It is now estimated that if all the polar ice were to melt, an amount of water would be released which would raise the level of the oceans of the world by over four hundred feet. Gondolas in New York? Submarines might become necessary.

Every person who has looked at a globe will have noted that there is about three times as much water as land area. Even this does not tell the complete story of the vastness of stored water, for the depth of the ocean basin is obscured. If we were to consider the earth as a smooth ball for a moment, there is enough water in the ocean to cover the ball with a sheath nearly two miles in depth. This is the water which has been accumulated over eons of time. During these eons, before our present atmosphere came into existence, the cooling earth released oxygen which combined with the hydrogen in the air to produce water vapor. As this condensed and formed the thick mantle of clouds which surround the earth in years long past, torrential rains fell on the land. Also tremendous amounts of water were released from the molten rock as it cooled.

About one-twentieth of the earth's surface now is covered by ice and 90 per cent of all this ice is concentrated in Antarctica. One of the striking sights which first confronts the visitor in this far-off region is the long line of ice cliffs which come right to the sea. (See Figure 1) To learn more about the mysteries of the Antarctic continent, some sixteen over-snow expeditions were made by scientist of different nations during the recent International Geophysical Year (IGY). By setting off charges of powder and

measuring the time for sound waves to be reflected from the rocks of the continent below, the ice thickness was measured along the routes. The results of these soundings indicate there is as much as 40 per cent more ice covering Antarctica then had been suspected. The Byrd Station rests on 10,000 ft of ice extending to 5,000 ft below sea level. In Marie Byrd Land, Americans measured ice 14,000 ft thick resting on bed rock 8,200 ft below sea level. At the South Pole itself, ice was measured 8,297 ft deep but resting on rock above sea level. Based on this evidence, the estimate of the world's frozen water has been raised to 4½ million cubic miles. (See Figure 2)

Despite the magnitude of this figure there are indications it could have been greater in earlier times for mountain tops which now penetrate thousands of feet above the ice show evidence of having been scoured by glaciers.

Of course, this is not the first long-term warming trend the earth has experienced. Our present relatively warm period has lasted the geologically short time of 25,000 years following the Fourth Ice Age. This ice age persisted for approximately 100,000 years and brought its sheath of ice well down into middle latitudes. At that time, one would have seen ice cliffs along the 45th parallel of North America, a line roughly joining Portland, Oregon, and Portland, Maine. Since the ocean level was then much lower, much land now covered by ocean would have lain exposed.

The First Ice Age seems to have commenced about 600,000 B.C. and lasted about 50,000 years. This was followed by a warm period of 60,000 years. After the Second Ice Age, lasting 50,000 years, a Second Warm Period followed which persisted for a longer 190,000 years. The Third Ice Age followed for another frigid period of 60,000 years.

Though many theories have been advanced, scientists still are not in agreement about the causes for these radical alternations in climate. There is little direct evidence available at the present to account for happenings in the pre-scientific past ages. There are a few fairly well-founded theories suggesting answers to the present warming trend.

The major one is commonly called The Carbon Dioxide Theory. It was first advanced by the English natural philosopher, John Tyndall, in 1861. This theory is not too difficult to understand in its main outline for we have all had some experience with greenhouses. Their interiors warm up because they receive more energy than they lose. The short wavelength light energy comes unhindered through the glass; the longer wave length infrared radiation is not allowed to go out unhindered through the glass.

Carbon dioxide is one of the several gases which make up the last per cent of air, nitrogen and oxygen comprising 78 and 21 per cent respectively. The carbon dioxide molecules cause the earth's atmosphere to act like a greenhouse. Carbon dioxide is transparent to the incoming solar radiation. However, it strongly absorbs energy re-radiated by the earth in the infrared region of the spectrum, and this contributes to the warming of the earth's atmosphere. Though the water vapor and ozone in the atmosphere act similarly, the amount of CO_2 in the atmosphere is the main factor in the warming of the atmosphere.

What determines the amount of CO_2 in the atmosphere at any time?

There are three great supply sources for carbon dioxide: the rocks, the oceans, and living organisms. It is estimated that the oceans each year exchange about 200 billion tons of carbon dioxide with the atmosphere. The carbon dioxide in the sea is mostly held in chemical bond as carbonates, bicarbonates and carbonic acid. In the surface layers

Fig. 2. CONTINENTAL ICE SHELF Weddle Sea, Antarctica. Official U.S. Navy photograph

of the sea which are transparent to light, photosynthesis of minute plants withdraws CO_2 from the water. This leads to a breakdown of the carbonates and bicarbonates and sets free CO_2 in the sea water to replace what the plants use up. In addition, the animals which feed on the plants give off CO_2. It is possible for the water which contains excesses of CO_2 to give this off to the atmosphere and vice versa. Both the atmosphere and the ocean exchange carbon dioxide with rocks and with living organisms. Weathering of rocks tends to reduce the atmospheric carbon dioxide. Volcanic activity and hot springs release gases rich in carbon dioxide into the atmosphere.

Much of the carbon dioxide contained in the atmospheres of geological ages which supported the growth of heavy foliage now is buried in the earth. This foliage now makes up our deposits of fuels. In the process of burning fossil fuel, man now releases some six billion tons of carbon dioxide into the atmosphere per year. Most of this ultimately will be absorbed again by the oceans. Computations show that in the past 100 years man has added about 360 billion tons of carbon dioxide to the atmosphere and has increased the atmospheric concentration of this gas by 14 per cent.

Pushing ahead the present rate of increase of fossil fuel consumption, a trillion tons of CO_2 will have been added to the air by 2000 A.D. This should result in a 3.6°F average increase in the earth's temperature. When all the known reserves of fossil fuel will have been used up, the increased CO_2 will cause the average air temperature to be 10 degrees higher.

If this actually happens, we have to expect substantial melting of the polar ice cap and a slow encroachment of the ocean onto the land. Neither the reader nor the author will be here to see the results, but it forebodes some interesting real estate problems for citizens of the future.

Crawford, Murphy and Tilly Appoint Four Associates

The consulting engineering firm of Crawford, Murphy and Tilly, Springfield, Ill., has announced the appointment of four employees as Associates of the firm. Re-organization of the firm structure has followed the recent retirement of Ray V. Tilly, former partner. Those appointed are: Charles L. Ritchie, Donald E. Thompson, Carl A. Wieland and Elmer E. Young.

Cramer Cites Water Supply Needs for Fire Fighting Purposes

AWWA vice president, John W. Cramer, addressed the 65th Annual National Fire Protection Association's Conference May 18, and outlined the extent to which the nation's water supply expansion would be the result of providing adequate fire fighting facilities.

Cramer pointed out that this country's water supply systems will need a $25 billion "transfusion" over the next 20 years to correct present deficiencies and meet expected demands. However, he indicated, the cost of expansion would be far less if fire protection needs did not have to be provided for. Water utilities accept without question the responsibility to "deliver enough water where you need it" for fire fighting purposes.

It was further pointed out that the nation's yearly bill for fire losses now amounts to more than $1.5 billion. The expense of improving our water supply systems amounts to about $1.65 billiion annually. The cost of fire losses and prevention can be roughly estimated from these figures.

Another item cited by Cramer was that of about 20,000 U.S. public water supply utilities, more than 50 per cent have plant and distribution deficiencies of one kind or another, and it will cost about $5 billion just to correct these conditions.

The NFPA meeting was held in Detroit, and more than 1500 fire experts from the United States, Canada and other countries attended.

Kansas Packers Appeal Treatment Directive

Three packing companies and the Kansas City Stock Yards Co., have filed an appeal in the Wyandotte County District Court to deter a recent order of the Kansas State Board of Health which directed them to initiate a sewage treatment program. Judge Harry G. Miller, Jr. signed an order staying all proceedings of the Board and the effectiveness of a March 10, directive until the appeals are heard. No date was immediately set for the hearings.

The Board's order called for the following steps: each firm to have submitted to the Board's Sanitation Division on or before April 15, plans it would follow in pollution abatement; that in the event such company had indicated a plan to install its own treatment facilities, it shall on or befor September 15, submit a comprehensive engineering report outlining needed facilities and other plans for review and approval; that where such a company has proceeded on a treatment program, it shall on or before April 1, 1961, submit to the Division final engineering plans and specifications for review and approval; and that on or before July 1, 1962, all such remedial facilities shall be placed under contract for construction.

The packing companies involved are Swift and Co. Wilson and Co., and the Central Packing Co.

Dayton Has Sewage Treatment Plans Prepared

The City of Dayton, Ohio has authorized the preparation of plans and specifications for the first phase of an overall program of sewage treatment plant improvements. Havens and Emerson, consulting engineers of Cleveland have submitted a report outlining the program and are now preparing the construction plans.

Recommend Bill to Protect Against Water Pollution

Wisconsin State Senator Walter Hollander recently introduced a bill in the state legislature that would permit suits covering damages resulting from water pollution. Hollander cited an incident that occured in his (Rosendale) area in which a creamery dumped whey into a gravel pit during the winter months. When the spring thaw came, the whey seeped through the gravel and polluted wells in the area.

Under existing Wisconsin law, the property owners, and any others confronted with a similar predicament, have no recourse for the damages incurred.

A discussion of the application in the water works industry of . . .

Automatic Control of Chemical Addition

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■ AUTOMATIC CONTROL is necessary in the water treatment field when chemicals such as alum, chlorine, etc., are to be added in proportion to flow. Control is also required for the correction of concentrations such as pH, fluoride, and chlorine. Both of these requirements are very important in today's water treatment plants which, in many instances, are operated at varying flow rates. While it is possible to manually control the feeders which operate on this type of schedule, it is not in the real sense of the word practical. Many of these functions cannot be carried out with the manpower normally available in a water treatment plant. The result is that automatic control of chemical addition must be applied in varying degrees to almost all modern water treatment plants.

Two basic types of control are used: the so-called open loop and the closed loop. Open loop is typified by the usual method of setting a chemical feeder in proportion to flow rate, the feeder being operated by a signal from a water flow meter with no actual measurement of the amount of chemical being fed. The accuracy of this system depends entirely upon the accuracy of the feeder and its controls. The second type, closed loop, is typified by a liquid alum flow system where transmitting measurement equipment is used. In this system, an actual measurement is made of the quantity of alum being fed. This is compared against a desired quantity of alum and corrections continuously made to hold the actual quantity equal to the desired quantity. This control technique provides a high degree of accuracy.

By and large, most of the automatic control problems concern addition of chemicals in proportion to flow, the normal way in which coagulants, activated carbon, chlorine and fluorine are added. In the case of lime or soda ash, such proportioning is practical where there is a constant pH of the influent.

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Open Loop Control

The most common method of addition in proportion to flow is open loop control, with the impulse duration type most widely used. Impulse duration control is applicable to dry feeders of both the volumetric and gravimetric type, to chlorinators of all types, and to positive displacement metering pumps. Although, for practical purposes, it is universally applicable, it is not always the wisest choice when all factors are considered. Impulse duration control is based on a cam contacting mechanism, which operates in the manner illustrated by Fig 1. The contactor is positioned by a sensing element and is operated in conjunction with a cam turning at a constant rate. Cam cycles for chemical feeder control range from 12 seconds to 60 seconds per cycle. One type of contactor rides under the cam at the beginning of the cycle and there is no signal. When it leaves the trailing edge of the cam, the signal starts and continues until the leading edge of the cam is again encountered, at which time the cycle repeats itself. The result is that at 50 per cent of scale on a 12-second cycle, electrical contact is made during the last six seconds of the cycle. This type of control does not depend upon signal level but only signal duration. It is basically the way integrators or flow totalizers operate.

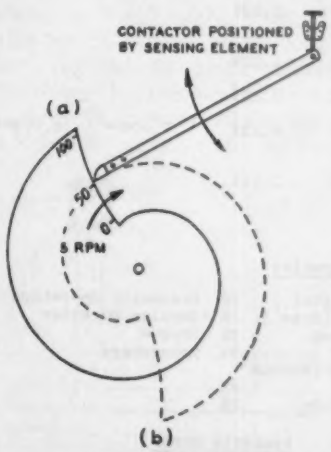

FIG 1 CONTACTOR for impulse duration control

Most impulse duration controllers are conventional integrating flow meters with an additional relay to carry the electrical load of the starting equipment for the feeder. Fig 2 illustrates the type of signal in impulse duration control. The upper half of the figure illustrates a hypothetical case in which flow actually makes stepwise changes, each of which is one cycle in duration. The total flow, or the area under the flow curve, is equal to the area under the impulse duration curve; therefore, 100 per cent accuracy is being achieved. In the lower part of the figure, the flow curve is changing linearly over both a 1 and 2 cycle period. There is no difference between the integrated area under the flow curve and under the pulse curve. In the long run, very small errors will be occurring between the impulse duration signal and the actual flow measurement. The instantaneous pulse will be in error from the flow but will normally average out over a period of time.

The advantage of impulse duration control is that a relatively inexpensive flow meter is adequate for the job. In many cases it has been suggested to engineers that if there is any possibility of needing feeder control in the future, the flow meters should be purchased with impulse duration units built into them. Since it is merely a matter of adding a

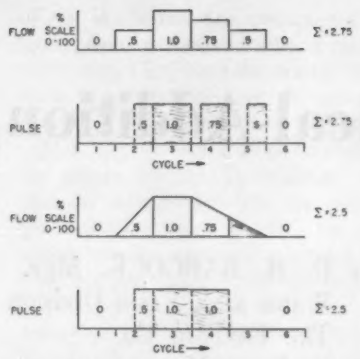

FIG 2 RELATIONSHIP OF FLOW to totalized (integrated) impulse duration signal (open loop control)

relay during manufacture of the conventional integrating flow meter, the expense is small. Once this equipment is in the meter, it is possible to control feeders in the future without instrument modification. The feeder adaptations for this type of control are inexpensive. Only a 3 phase motor and an across-the-line magnetic motor starter are needed. Three-phase motors and across-the-line motor starters are used for long life and low maintenance of the feeder motor. The comments with regard to inexpensive adaptation of the feeder do not apply to chlorinators, which require a device for conversion of the impulse duration signal to a vacuum signal that may run into hundreds of dollars. Other possible means of control for chlorinators will be discussed later in this paper.

Another type of open loop control for chemical feed utilizes pneumatic transmission. It is readily adaptable to all of the previously noted types of feeders. Fig 3 illustrates the relationship of flow to the pneumatic signal. It is observed that one follows the other exactly, with none of the inaccuracy present in the impulse duration system. This system requires relatively inexpensive instruments. Its total cost runs about the same as an impulse duration controller but usually it requires a rather expensive feeder adaptation in the form of an air motor which varies the feed rate in proportion to flow. In addition, it requires a 20 pound air supply. This type of control is readily applied to all types of feeders but most logically applied to the gravimetric type. It can be applied where there are rapidly changing flows.

A related type of control is based on vacuum transmission which utilizes a vacuum transmitter consisting of a mechanical flapper nozzle relationship device similar to that used in the pneumatic systems except that air is drawn through it rather than applied to it. The ejector in the chlorinator furnishes the vacuum

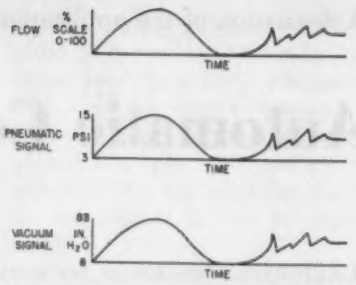

FIG 3 RELATIONSHIP OF FLOW to pneumatic and vacuum signals (open loop control)

and the vacuum controller constitutes a controlled leak in the vacuum system. Readily applied to most modern chlorinators, it requires an inexpensive instrument and an inexpensive chlorinator adaptation. It provides accurate control of the chlorinator in proportion to flow with neither compressed air nor electricity required. It is probably the best method of controlling chlorinators in proportion to flow rate in the smaller and medium size installations. The main advantage is that it continues to function as long as there is a water supply to furnish a vacuum to the ejector of the chlorinator.

Closed Loop Control

Closed loop control actually makes a measurement of the quantity of chemical being delivered and compares it against the desired quantity. Through this technique, precise control is possible. For practical purposes, it is limited to control of liquids and is typified by the control of liquid alum flow with an integral orifice differential pressure cell. Here, the liquid alum flow to the injector is regulated by a control valve which, in turn, is actuated by a recorder controller receiving a measurement signal from an integral orifice differential pressure cell transmitter. Better control than is possible with volumetric feeders and positive displacement pump is readily achieved. Normally no re-pumping of the chemical is required and the overall installation is simplified. Control of alum feed rate in proportion to plant influent is readily accomplished with this type of equipment, as illustrated by Fig 4. In this case, the control index of the alum flow controller is set by the plant influent rate. If the influent rate changes, the alum rate changes in proportion.

Table I

Errors for Dry, Liquid and Gaseous Feeder Pacing at 100% of Flow

	Impulse Duration % Pulse		Pneumatic 3-15 PSI		Vacuum 8-88 In. H_2O Vacuum	
	Maximum	Probable	Maximum	Probable	Maximum	Probable
Dry Feeder Volumetric	5.75%	5.05%	6.50%	5.12%		
Dry Feeder Gravimetric	1.75%	1.25%	2.50%	1.50%		
Metering Pump	2.75%	2.13%	3.50%	2.29%		
Chlorinator	5.75%*	4.18%*	5.50%	4.15%	7.00%**	6.07%**
Feedback Ratio Control (Liquids)			2.00%	1.41%		

Individual Accuracies

Impulse Duration	.75%	Dry Feeder (Vol.)	5%	Pneumatic Operators	1%
Pneumatic	.5%	Dry Feeder (Grav.)	1%	*Impulse Duration	
Vacuum	1.0%	Metering Pump	2%	Vacuum	
		Chlorinator	4%	Converters	1%
		**Chlorinator (Vacuum Control)	6%		
		Feedback Loops	1%		

Maximum Error

$$= E_1 + E_2 + E_3 + \ldots\ldots E_n$$

Probable Error

$$= \sqrt{E_1^2 + E_2^2 + E_3^2 + \ldots\ldots E_n^2}$$

Dosage is adjustable within the instrument by changing the ratio between the two flows. This type of control is applicable to alum, caustics, acids and, in general, all fluids normally utilized in water treatment practice.

It should not be overlooked that chemicals fed as liquids in many cases result in greater efficiencies than realized with the dry form of the same chemical. An example is alum. At the Salem and Beverly Mass., Water Supply Board filtration plant, an average reduction of 19 per cent in alum consumption, dry weight, has been realized by conversion from dry to liquid alum.

A comparison, Table 1, of the expected accuracies with various types of control reveals some interesting facts. For dry feeders and metering pumps, simple, inexpensive, impulse duration control is more precise than other types, providing the rates of flow change slowly. For chlorinators, the simple inexpensive vacuum transmitter is sufficiently accurate to handle most applications. Liquid feed control is most accurately accomplished by feed back ratio control. Except with rapidly changing flows, pneumatic control of dry feeders and metering pumps is least accurate. For normal water works installations, it can be concluded that impulse duration control is the logical selection for dry feeders, and metering pumps and vacuum control for chlorinators. Feedback ratio control is most accurate for solution feed with the additional advantages of recording and continuous monitoring of feeder operations. It is apparent that accurate feeder pacing does not necessarily require elaborate and expensive equipment.

Concentration Control

A second type of closed loop control is concentration control in which the actual concentration of a substance is measured and the dosage then corrected so as to maintain concentration at a constant level. This type is illustrated by pH control, residual chlorine control, fluoride control, etc. Except for pH control, it has not been widely adopted in water treatment practice to date but should be in the future.

A typical closed loop control pH system is shown in Fig 5. The pH electrode is located in the pipeline and transmits an electrical signal to a pH recorder controller which, in turn, furnishes a pneumatic signal to operate a pneumatic control valve and admit chemical for pH correction.

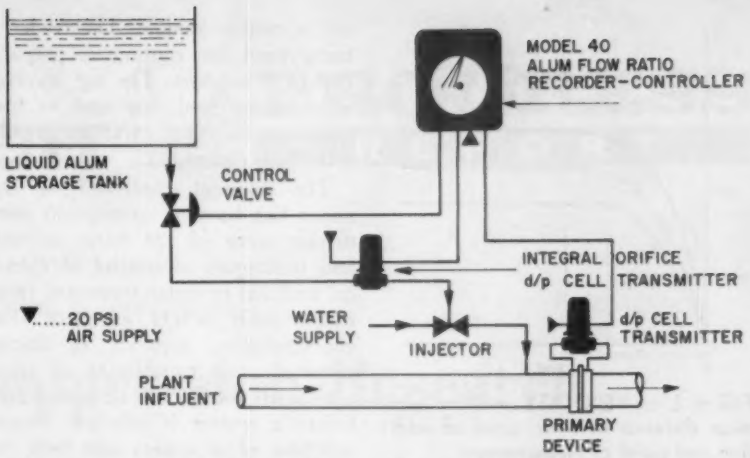

FIG 4 SCHEMATIC DIAGRAM of closed loop control of liquid feed

Some important cautions must be observed in the application of pH control. Although pH appears to be linear on the scale, it is actually a logarithmic value and the scale is a linear expression of a very nonlinear characteristic. A pH change of 1 unit represents a tenfold change in H^+ concentration.

Note that Fig 5 shows a dimension "L". Fig 6 establishes "L" as the minimum distance between the point of addition and the point of measurement. This minimum distance is best established by laboratory experiment in which units of acid or alkali to be used in the actual plant are added to the water and the pH observed over a period of time. For different dosages, a family of curves similar to Fig 6 might result. The value for "T" should be the longest time required to reach stability. Therefore, "L" becomes the velocity $\times$ time. If acids or alkalis are to be delivered to the water in liquid form, time is not normally a problem because the reaction rate is, for practical purposes, instantaneous. However, with materials such as dolimitic limestone, reaction times are very long. To control a system where the dimension "L" is less than the minimum distance is difficult, if not impossible. There will be wide differences between the laboratory pH measurements of the water, taken at a point farther downstream, and those shown on the recorder controller. Also the recorder controller will have a difficult time controlling because the reaction is in a transient state. Many pH installations in water treatment plants do not operate satisfactorily simply because this simple laboratory procedure was not performed before the installation was designed and placed in service. Another effect which must be considered in the application of pH recorder controllers is the buffering capacity of the water. The pH control point should be selected with accurate knowledge of the buffer points.

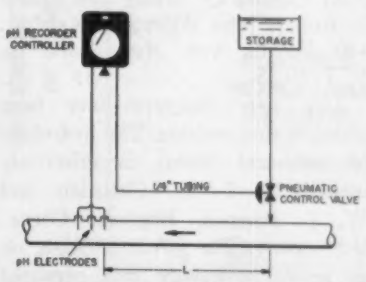

FIG 5 SCHEMATIC DIAGRAM of pH control system (closed loop control)

Although not always practical from a chemical handling standpoint, pH correction through the feeding of a liquid is preferred to dry chemical feed with the controller changing the rate of a dry feeder. Serious lags in the dry feeder many times make pH control with this type of feed almost impossible.

One means of avoiding or minimizing feeder delays on concentration control is to use a volumetric type of dry feeder, operating at a fixed rate higher than the maximum required and controlling feed with a control valve, Fig 7. Level con-

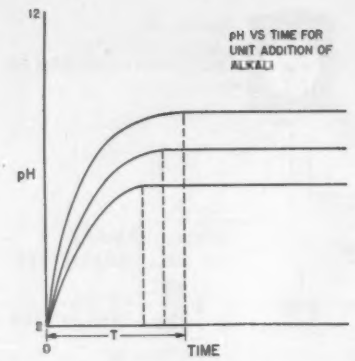

FIG 6 L = VELOCITY × T = minimum distance between point of addition and point of measurement

trols are necessary on the feeder to prevent flooding the solution tank. This results in an essentially liquid feed system providing the dry chemical is readily soluble. The feeder is being used for continuous preparation of a solution. The lag involved in changing feed rate and in turn changing the concentrations in the solution is eliminated.

The material contained in this paper has been an attempt to summarize some of the basic methods and techniques of control of chemical addition to water treatment processes. Such factors as plant flow characteristics, accuracy of dosage required, and capabilities of plant personnel should all be considered before a system is selected. Proper selection of a system can help the plant realize better treatment at a minimum expenditure for chemicals.

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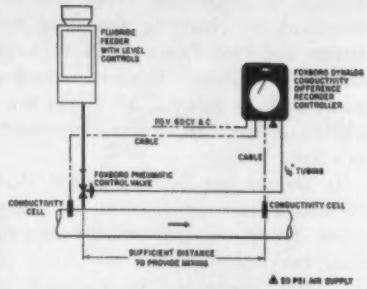

Fig 7 SCHEMATIC DIAGRAM Installation of Fluoride Concentration Recorder-Controller

Book Reviews . . . .

WATER—SUPPLY, DEMAND, AND THE LAW-(Resources for the Future reprint series: No. 15)

By Irving K. Fox. Single copies of the reprint free on request. Additional copies 25 cents each.

This paper was presented before the Section of Mineral and Natural Resources Law of the American Bar Association, Miami Beach, Florida, August 25, 1959. Reprinted from its 1959 "Proceedings."

SEQUENCE AND TIMING IN RIVER BASIN DEVELOPMENT-(with special application to Canadian-United States Columbia River Basin planning).

Resources for the Future, Inc., 1145 Nineteenth Street, N. W., Washington 6, D. C. Price is 75c.

This 40-page booklet is a contribution to current economic analysis in river basin planning and project evaluation. The author, John V. Krutilla, uses the planning of joint United States-Canadian development of the Columbia River Basin as a means of demonstrating the theory that it is essential to determine the proper sequence of project additions to a system over time, in order to estimate the contribution of particular projects to the system's output and to maximize the net benefits from development.

Mr. Krutilla is research associate with Resources for the Future and, with Otto Eckstein, is author of "Multiple Purpose River Development—Studies in Applied Economic Analysis", published by the Johns Hopkins Press in 1958.

PROCEEDINGS OF THE 1959 AIR & WATER POLLUTION ABATEMENT CONFERENCE

Manufacturing Chemists Association, Inc., 1825 Connecticut Ave., N.W., Washington 9, D. C. Price, $2.00 each. 161 pages.

Included in this publication are eleven papers which were presented at the Conference together with all the pertinent charts, graphs and illustrations. The Conference was held March, 1959 in Cincinnati.

HYDROLOGY, Second Edition

By Chester O. Wisler and Ernest F. Brater. John Wiley & Sons, Inc., 440 Fourth Ave. New York 16, N. Y. $9.25.

Two new chapters have been added in this revision. The hydrology of semi-acid basins is effectively treated by F. G. Christian and W. J. Parsons, Engineer Corps., U.S. Army. The effect of snow on an area's hydrology was prepared by Walter T. Wilson, U. S. Weather Bureau.

The book also explains the use of the Hydrograph in determining flood magnitude and frequency. The authors deplore the absence of stream discharge data since at least twenty years are required to correctly evaluate many stream's tendencies toward unusually large or small discharges. V.W.L.

Albertson Opens Consulting Engr. Practice

Murray G. Albertson has announced the opening of a consulting engineering practice at 14 Englewood Road, Rowayton, Conn. He will specialize in the sanitary engineering field, including sewage and water systems and the treatment of industrial wastes.

He is a licensed professional engineer in Connecticut, New Jersey and New York, a member of the ASCE, the Connecticut Society of Professional Engineers, and the New England Water Pollution Control Association.

Cline Receives Atlanta Post

Mr. C. W. Cline has been appointed Chief Engineer of Construction of the Atlanta Water Department. He succeeds Mr. Roy Ruggles who recently retired.

Mr. Cline has been employed in the Engineering Department for 14 years. He is a registered professional engineer, a member of the AWWA, and a registered land surveyor in the State of Georgia.

RESEARCH PROGRESS REPORT

Recent laboratory and pilot scale work is reported on . . .

Evaporation Suppression Research

Part II

by JOSEPH B. FRANZINI
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EDITOR'S NOTE: Continuing this evaporation suppression research, Dr. Franzini reports on the work being done to find more effective chemicals and on the application of chemicals for evaporation suppression to a pond on the Stanford campus. From this and other work, it has been possible to develop some idea of the amount of water which can be saved and its cost. It appears that reductions in evaporation in the order of 20 per cent are possible and that under ideal conditions costs will range from $20 to $35 per acre-foot.

■ DURING THE PAST TWO years research on evaporation suppression has been conducted at Stanford University under the direction of the author with the financial support of a grant from the U.S. Public Health Service. Effort has been exerted along several lines. Considerable work was done in the laboratory using the Langmuir tray in an attempt to find a chemical or combination of chemicals or an additive that could be mixed with hexadecanol to give a film with superior healing qualities while retaining proper evaporation inhibiting characteristics. This work has not yet produced any promising results.

Pan Tests

Numerous tests using evaporation pans were conducted at the University Weather Station. These are metal pans 47.5 in. in diameter and 10 in. high filled with water to a depth of 7 in. One pan filled with only water is used as control while varying dosages of different chemicals are placed on the water surfaces in the other pans. The differences in evaporation from the pans are observed over a suitable time period by adding enough water each day to keep the water levels constant. Some of the

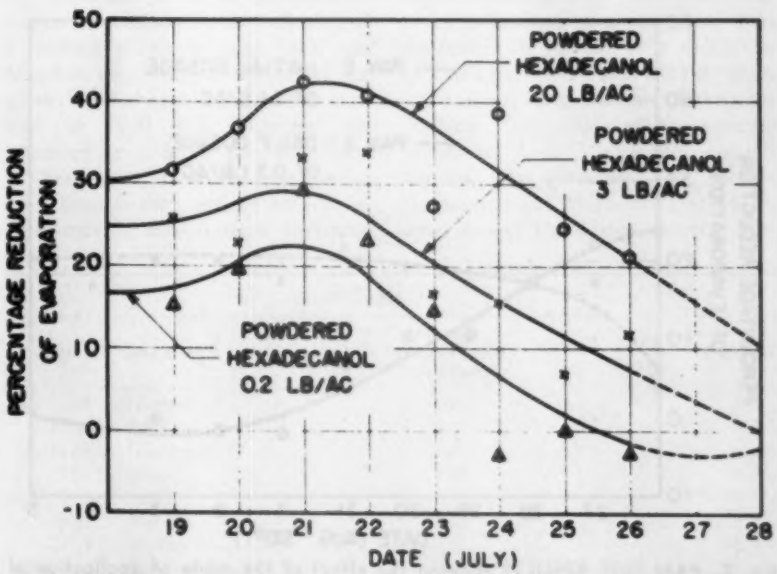

Fig. 5. RESULTS OF PAN TESTS showing the effect of varying dosage.

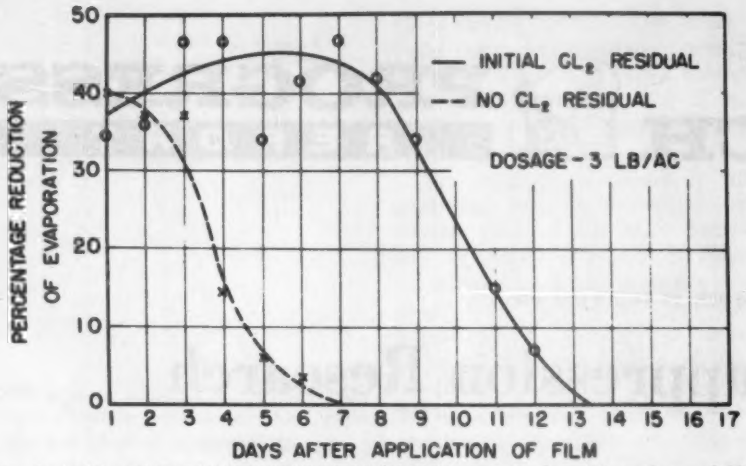

Fig. 6. THE EFFECT OF CHLORINE RESIDUAL on powdered hexadecanol film in pan tests.

results of the pan tests are shown in Figs 5, 6, and 7. Fig 5 shows the effect of varying dosages on the reduction of evaporation. As would be expected the largest dosage was most effective. Moreover its effectiveness persisted for a longer period of time. The results of Fig 6 showed that the chlorine residual apparently impeded bacterial activity giving the film greater effectiveness and longer life. Fig 7 shows that the initial hexadecanol dosage of 3 lb per acre lost its effectiveness in about six days indicating that the rate of bacterial attrition may have approached 0.5 lbs/acre/day. Applying a small dosage each day gave much better results than the application of one large initial dosage.

It is a well known fact that a monomolecular film will raise the temperature of the water surface on which it rests. Fig 8 shows some typical temperature data that were obtained from evaporation pans, one dosed with 3 lb per acre of hexadecanol and the other containing plain water. The temperatures were obtained using a multi-channel recorder connected to copper-constintan thermocouples serving as sensing elements. The water surface temperature in the pan with film exceeded that in the pan without film by as much as 7°F.

Lake Trials

At Felt Lake, a 40-acre lake on the Stanford campus, a program of full scale evaporation suppression testing was carried on during the summer of 1960. The pattern of testing was a film on, film off procedure; i.e., a several day period with film followed by a several day period without film and repeat. The percentage reduction of evaporation was evaluated by the pan coefficient approach. This consists of determining the lake evaporation by means of a water budget during periods of film and no film, and comparing them with the corresponding evaporations from a pan. This technique is open to criticism because pan coefficient, the ratio of lake evaporation to pan evaporation, is known to vary considerably throughout the year; however it is a convenient and expeditious method.

In recent years the lake had been the site of basic research on evaporation, hence there was a background of experience on the characteristics of the lake. There was enough available data to estimate seepage from the lake with a fair degree of accuracy. During the testing program there was no inflow to the lake. Outflow was measured by a recording venturi meter that had been recently calibrated and the change in lake water level was measured with a water level recorder installed in the concrete outlet tower. The relation between water surface elevation and lake surface area was available from an old survey. Since the original survey there had been very little sediment deposited in the lake as the lake is filled by the controlled diversion of water from a natural stream. Using a water budget approach the evaporation from the lake was computed. This was compared with the evaporation from a evaporation pan situated nearby on an unobstructed hill.

A tabulation of the results is shown in Table 1. It should be noted that there is an inconsistency in the results. The pan coefficient of 1.05 during the film period July 27-31 is difficult to explain. It is believed that during this period the evaporation pan was contaminated with hexadecanol and, hence, the pan readings were in error. Comparison of the pan records with pan evaporations at the Stanford Weather Station indicate the plausibility of this conjecture. Neglecting the computed pan

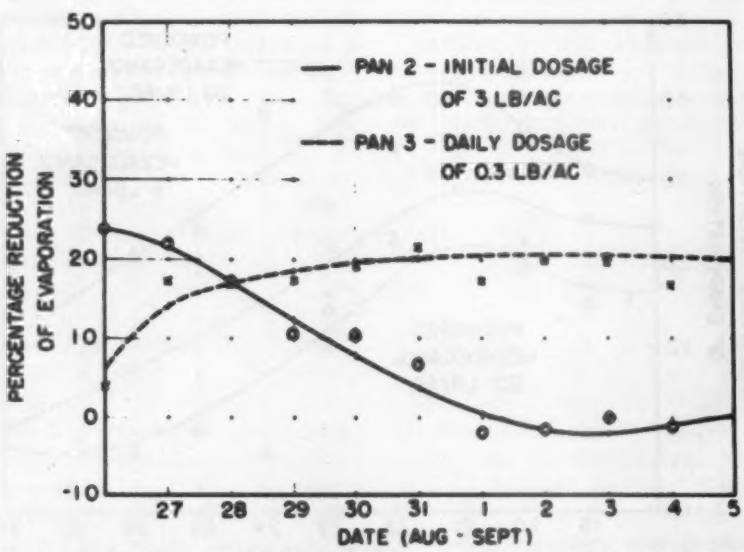

Fig. 7. PAN TEST RESULTS showing the effect of the mode of application of powdered hexadecanol.

coefficient for the questionable period gives an evaporation reduction of 23 per cent while using all computed pan coefficients results in a 19 per cent reduction.

Chemical Application

The technique of applying the chemical to Felt Lake was to dispense the powdered hexadecanol by hand from a boat. During periods of film application the operator was generally at the lake from nine o'clock in the morning to about seven in the evening. The chemical was distributed about once an hour in those areas of the lake where it was needed. The amount of hexadecanol used varied from 5 to 25 lbs per day depending on the requirements; this is equivalent to dosages ranging from about 0.15 to 0.75 lbs per acre per day. During Aug. 16-26, a windy period with a wind velocity index of 6.6 mph, the dosage averaged 0.40 lbs per acre each day while from Sept. 5-14 with a wind velocity index of 4.0 mph the average dosage was only 0.21 lb per acre per day. The wind velocity index was computed by averaging the wind velocities as measured at 10:30 AM and 4 PM by a portable anemometer situated on a raft in the middle of the lake 12 feet above the water surface. The film coverage varied but on the average was about 50 per cent during daylight hours and 95 per cent at night. There was very little wind from 8 in the evening until 10 in the morning. At 10 AM a northerly breeze generally came up necessitating the application of some hexadecanol to maintain the film. The wind usually grew stronger as the day wore on finally reaching a peak around 5 PM and then subsiding gradually to a negligible wind velocity by 8 PM.

The chief difficulty in accomplishing effective evaporation suppression is maintaining adequate film coverage on the reservoir surface. Apparently this can only be accomplished by applying the chemical continuously during windy periods to replace the film blown away by the wind.

Dispensing the chemical by hand can be an expensive operation because of the high labor costs. To reduce labor costs an attempt was made to develop a dispenser that could be set in operation and then left unattended for one or more days. Since the amount of chemical required is roughly proportional to the wind velocity it seemed logical to develop a wind-actuated dispenser. Attempts to develop a dry feed dispenser have thus far been unsuccessful because of the binding of the powdered chemical in the worm drive or other feeding mechanism. Since hexadecanol and other film-forming chemicals have a low melting point in the vicinity of 130°F it seemed that dispensing the material in the molten state might be possible. In the fall of 1959 a molten dispenser was built and tested in the Stanford University Engineering Laboratories. In the summer of 1960 this dispenser was mounted on a large raft and tested at Felt Lake. It worked reasonably well though the need of certain refinements in design were indicated. This device maintains the hexadecanol in a molten state with a butane heater equipped with a thermostat. A large anemometer-like rotor is used to drive a rotating cam which pulls a piston against a spring to admit molten hexadecanol into a small cylindrical chamber. As the cam rotates the piston is released and the spring forces a slug of molten hexadecanol into a long metal tube which terminates with a pin-hole nozzle permitting the molten material to eject into the atmosphere. The molten material is emitted as a fine spray that condenses in the air to a multitude of small particles which hit the water surface and form the film. The major problem was that with moderate winds of 2 or 3 mph not enough torque was generated to operate the mechanism. With stronger winds, even though the device operates fair-

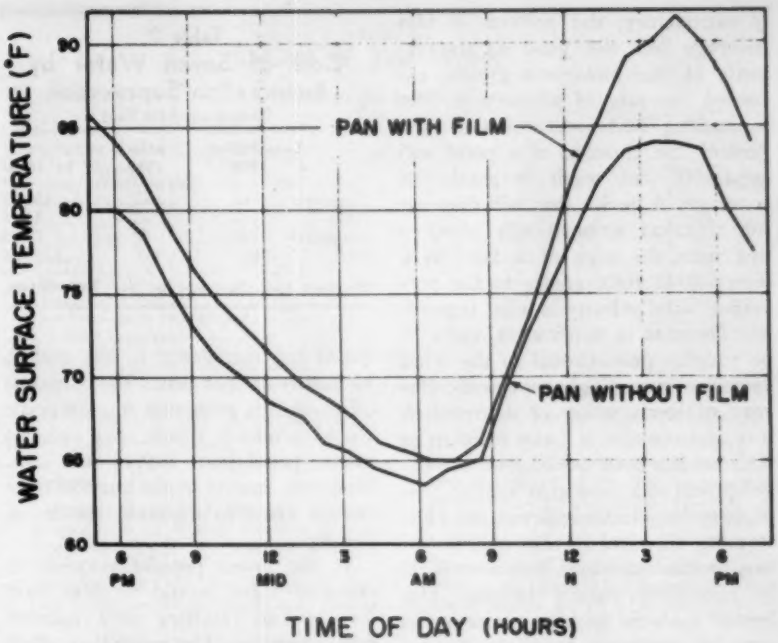

Fig. 8. THE EFFECT OF FILM on water temperature.

Table I

Date	Condition	Average Pan Coefficient During Period	No. of Days
July 7-11	No Film	0.69	5
12-20	Film	0.47	9
21-26	No Film	0.82	6
27-31	Film	1.05	5
Aug. 1-15	No Film	0.93	15
16-26	Film	0.88	11
27- 4	No Film	1.21	9
Sept. 5-14	Film	0.90	10
15-23	No Film	1.16	9

ly satisfactory, the pattern of film coverage was not good as the velocity of film movement greatly exceeded the rate of advance of film formation. This indicates that dispensing the chemical at a point will apparently not result in good film coverage. A device that will dispense the chemical automatically along a line near the edge of a lake in a direction at right angles to the prevailing wind velocity is what is needed. The rate of application ought to be roughly proportional to the wind velocity. Interestingly enough the Bureau of Reclamation in its research this past summer at Lake Sahuaro in Arizona has been working on the development of a somewhat similar type of dispenser. In their device the film-forming chemical is also maintained in a molten state by a thermostatically controlled butane burner. The heated material is kept under pressure by surcharge from the butane fuel tank. A small anemometer actuates an electronic relay which operates a release valve permitting emission of the molten material through a fine nozzle. This happens when the wind velocity reaches a certain level. The relay system is designed to cut off when the wind velocity exceeds 20 mph. At such a velocity application of the chemical is useless as the film is blown away much too quickly to do any good.

Effects on Insects

In connection with the work at Felt Lake data were gathered on the effect of the film on the emergence of insects from the lake. Four insect traps, were set in the lake. These were constructed of plexiglass in the shape of a cone and attached to a cork ring for flotation. A collecting bottle was placed in the inverted position over the upper opening of the trap to catch the emerging insects. Four traps were used: the water within two of the traps was free of film while a hexadecanol film was maintained on the water surface in the other two traps. During the test period the collecting bottles were replaced twice a day, at 6 AM and 6 PM. The insects that had been trapped were taken to the laboratory, identified, and counted. The Tendipedidae, midge, was the most common insect and was used as the basis for data. A statistical analysis of the count showed that the film had reduced the emergence of the midges by nearly 70 per cent. The longtime effect of this reduction in emergence would probably result in a reduced insect population within the lake. However, insects might migrate from nearby areas to maintain the insect density.

If the insect population were to decrease there would be less food for the fish resulting in a reduced fish population. The immediate effect of the decrease in insect emergence however as indicated by inspection of fish stomachs was that those caught during film application contained more insects than those caught during periods when the film was not applied. Not enough data were gathered however for conclusive results.

Because of innumerable variables and other factors no definite conclusions can be drawn at this time on the long time effect of a film on the fish.

Table 2
Cost of Saved Water by Evaporation Suppression
Dollars per Acre Foot

	Lake Hefner, 1958	Stanford 1960	Ideal
Chemicals	46	43	15 - 25
Labor	6	110	3 - 5
Equipment*	9	12	2 - 5
Total	$61	165	$20 - 35

*Includes Fuel, Maintenance, and Depreciation.

Cost of Evaporation Suppression

Various investigators have quoted the cost of conserving water by reducing evaporation through the use of monomolecular films. Costs as low as $6 per acre foot have been mentioned; however these seem to be entirely unrealistic. Table 2 gives some representative cost figures.

It is interesting to note that the cost of chemicals in the Lake Hefner tests of 1958 and those at Stanford in 1960 were almost identical. At Lake Hefner the hexadecanol was purchased in carload lots at 51.5 cents per pound while that used at Stanford purchased by the barrel cost 60 cents per pound. Even though the cost of chemical was higher at Stanford, the cost of chemical per unit of saved water was slightly lower. An explanation of this reversal is that at Stanford a considerably greater percentage of a real film coverage was achieved as the Stanford lake, 40 acres, was much smaller than Lake Hefner, 2500 acres. As the demand for film-forming chemicals increases and the techniques of manufacture improve, the cost of chemical will drop. At Lake Sahuaro in Arizona in the summer of 1960 the chemical, a mixture of octadecanol and hexadecanol, was purchased for 25 cents per pound. Hence a chemical cost of $15 to $25 per acre foot of saved water seems reasonable today. In future years this cost may decrease sizeably.

A comparison of the labor costs at Lake Hefner and Stanford requires explanation. The technique of dispensing the chemical at Stanford by boat was not an economic one for such a small lake. Actually the boat operator spent the majority of his time making limnological and meteorological observations in connection with the research program. However, all of his time was charged against labor for dispensing the chemical as he would have to have been on duty at the lake all day to accomplish this job properly. If he were only dispensing chemical he could have serviced a lake many times larger than the Stanford lake.

A labor charge as low as $3 to $5 per acre foot of saved water appears to be easily within reach under ideal conditions. These conditions imply a reservoir of optimum size, perhaps 1000 to 2000 acres per boat and operator. The reservoir should have a minimum of inlets and coves. It should be located in an area of high evaporation and the winds should be moderate. Small reservoirs, less than 100 acres, can perhaps be most economically dosed by use of floats, while intermediate sized reservoirs, 100 to 1000 acres, might, under proper conditions, be dosed effectively with automatic dispensers. Under good conditions the cost of equipment including fuel, maintenance and depreciation could be as low as $5 per acre foot of saved water and under optimum conditions as low as $2 per acre foot. The film method will not work well on very large reservoirs because the long reaches permit the formation of large waves that break up the film.

It is entirely possible to save water by the application of monomolecular films on reservoirs at a cost ranging from $20 to $35 per acre foot.

It should be kept in mind however that these cost figures apply only to selected reservoirs, those of proper size and shape in areas of moderate wind and high evaporation.

What of the Future

It appears that evaporation suppression by chemical means may shortly become an accepted method of conserving water in certain areas. A comparison with the costs of alternate sources of water (Table 3) shows the monomolecular film method to be competitive.

It should be borne in mind that the film method will not produce great quantities of water. Before resorting to the method careful advance study is in order to ascertain the probable cost of the saved water. This cost should then be compared with costs of alternate sources of water before a decision is made to apply the method. Much research and developmental work remains to be done before the full potentialities of the method are realized.

Table 3
Cost of Raw Water

	Dollars per Acre Foot
Local Runoff	$ 3.00 - 10.00
Groundwater	$ 3.00 - 10.00
Imported Water	Variable
Reclaimed Waste Water	$25.00 - 40.00
Sea Water Conversion	
Distillation	$ 250 - 600
Solar Stills	$ 350
Freezing	$ 700
Ion Exchange	$8,000*
Electrolytic Action	$ 500*
Ion-Permeable Membranes	$3,000*
Evaporation Suppression	$20.00 - 35.00

*Considerably lower for brackish water

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4. Harbeck, G. E., and G. E. Koberg A Method of Evaluating the Effect of a Monomolecular Film in Suppressing Reservoir Evaporation—*Journal of Geophysical Research* **64**:1, (January (1959).
5. Roberts, W. J. Reducing Lake Evaporation in the Midwest—*Journal Geophysical Research,* **64**:10, (October 1959).
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Physiological Aspects of Water Quality Conference Proceedings Available

A conference of scientists was organized to investigate the present state of knowledge with respect to the physiological and toxicological aspects of certain chemical constituents in water. The keynote address was titled "Human Health and Well-Being and the Aqueous Environment."

The Proceedings of this conference make available for the first time a variety of detailed reports on the subjects of water quality, minerals and trace elements such as molybdenum, selenium, vanadium, and zinc were discussed. The effects of insecticides, presticides, and other organic substances were reviewed.

There has been a lack of interest and information concerning non-biological constituents of water Chemists and engineers have given some attention to his problem, but medical specialists, physiologists, toxicologists, biochemists, and biologists were called upon for contributions. A wide variety of future research studies will be needed to explore the significance of many chemical constituents.

Copies of the Proceedings (244 pages) are available upon request from: Chief, Research and Training Grants, Branch, Division of Water Supply and Pollution Control, Public Health Service, Washington 25, D.C.

Water and Sewerage Division Hold National Defense Meeting

Eighty-two members of the National Defense Executive Reserve for the Water and Sewage Industry were invited to Washington to participate in a conference called by the Business and Defense Services Administration of the U. S. Department of Commerce, May 23-24. This segment of the BDSA Executive Reserve consists of selected utility and industry officials designated to assume executive positions in the Federal Government in the event of a national emergency.

The Executive Reserve Conference this year was a work session devoted to typical problems which the Reservists would face if called to active duty. In addition to the work session, the Reservists were briefed on the latest developments in non-military defense.

While in Washington they met with Secretary of Commerce Luther H. Hodges, and other top administration officials.

Thomas R. Komline Cited by Commerce Secy. Hodges

Thomas R. Komline, president of the Komline-Sanderson Engineering Corp., of Peapack, N. J., was recently cited by Secretary of Commerce Luther H. Hodges for his work as an industrial mobilization aide while on temporary assignment with the Business and Defense Services Administration, U.S. Department of Commerce.

The Department's Letter of Appreciation, signed by Secretary Hodges, was presented by Acting BDSA Administrator, Thomas E. Drumm, Jr., as Mr. Komline concluded a six-month-tour of duty as Assistant Director for Mobilization Planning, in BDSA's Water and Sewage Industry and Utilities Division. Mr. Komline received as a memento of his service an American flag which has flown over the Capitol.

Mr. Komline came to BDSA under an arrangement by which industry makes the services of key executives available for temporary service—usually six months—without compensation from the Government. The assignment also qualifies them for membership in the National Defense Executive Reserve which would staff the operation of a production agency in event of national emergency.

Manual operators begins a series of articles concerning . . .

Butterfly Valve Actuators—*Part I*

by ABDON J. BRAZAITIS
Application Engr.
Henry Pratt Co.
Chicago, Illinois

Basic Manual Operator Types

■ The most common type and most widely used manual operator for butterfly valves is the totally enclosed worm gear reducer. This unit consists of a worm of hardened high alloy steel driving a worm gear usually made of gear type bronze. The entire internal is packed with grease for lubrication and rarely does the unit require repacking. "O" ring seals or similar seals prevent the lubricant from leaking from the gear case. These gear reducers are suitable for normal outdoor service. Many of the worm gear units available today are also equipped with anti-friction bearings on the worm shaft and worm gear hub, to absorb thrust and reaction forces, thus keeping friction losses at a minimum. One of the recent advances in the worm gear unit, designed for butterfly valves, has been to provide a worm gear made up of two pieces. The outer rim of the gear has teeth of gear bronze and is bolted to the hub of high strength steel. This hub of steel allows the hub to be splined internally to receive the butterfly valve shaft, as shown in Fig. 1. Note that the butterfly shaft has a coupling, shrunk fit and keyed, with external splines. When the worm gear unit is mounted on the butterfly valve shaft this splined connection allows fast coupling, no play, and high torque capacity. Stop settings for valve travel are usually located in the internals of the gear case and are factory set and ordinarily do not require field adjustments of any kind. An indicator arrow connected to the gear hub gives an accurate index of valve position. A typical worm gear unit is the handwheel type shown in Figure 2.

A second type of manual operator for butterfly valves is the screw, consisting of a screw and lever arrangement replacing the worm gear set. Two types of screw and lever operators are available as shown in Figures 3, 3A, and 4. The operator shown in Figure 3A is simply a traveling nut unit with the nut engaged with the lever by means of the roller bearings. The lever usually has double arms to prevent the nut from turning and is slotted to allow for the change in effective lever length as the nut travels along the screw. The operator shown in Figure 4 is more widely used and consists of a traveling nut and connects to the lever by means of an intermediate link thereby eliminating the need for slotting of the lever. The geometry of this linkage has another effect which is useful in certain valve applications. As the valve approaches the closed position, the increment of travel of the nut, to effect an increment of travel of the lever, increases rapidly, and in effect, "slows down" the operator as the valve moves closed. This is a useful feature on butterfly valves used in distribution mains in that the valve is substantially closed during the first half of the closing operation while at the same time sufficient area of valve is left open to dissipate the over-pressure created by shock wave, until the amplitude of these over-pressures reaches a safe level. The screw usually is an Acme type thread chosen to yield high strength and minimum friction and wear. Use of this type operator is increasing and especially in the higher torque applications where the screw, lever and intermediate link arrangement has considerable merit in performance and economy.

A variation of the screw and lever arrangement should be mentioned. This variation substitutes a ball-screw type arrangement for the Acme screw and nut and thereby affects a considerable increase in overall efficiency and in certain cases eliminates the need for additive gearing quite often required if a worm gear or Acme screw and lever arrangement is used. The ball screw set itself is not "self-locking" but there are devices available to provide this function. This is essential in a butterfly valve operator due to the tendency of the valve to close when moved slightly off the full open position. In general, the use of the ball-screw is usually governed by the economics of any given application and usually bears consideration at higher torque outputs.

The manual torque applied to the input shaft of a gear, or screw, unit is usually transmitted through a handwheel, chainwheel or a standard AWWA square nut. The handwheel unit is used where pipelines are readily accessible and is the most commonly used. The chainwheel drive is used where the butterfly valve is located in overhead piping. The valve is operated through a chainfall from the deck below. If the line is considerably above operating grade, a special indicator of larger proportions may be desirable, especially for throttling applications when chainwheel operated valves are used. The AWWA nut operator is principally used for valves installed in a vault or completely buried, with a tee wrench being used to open and close the valve. In the case of the buried unit, it is sometimes useful to furnish a valve box with a built-in valve position indicator. A typical illustration of a buried valve is shown in Figure 5. Other variations of applying input torque to the operator will be mentioned in subsequent sections.

Commonly Used Additions to Manual Operators

One of the additions to a manual unit used quite often is a "locking" device on the input shaft of the unit. This usually is a simple clamp or ratchet pawl arrangement and in the industry today the term "locking" is still applied. If a true "lock" is required, the best and most common is still the chain and padlock arrangement with the chain circling one of the handwheel

spokes. As mentioned previously the worm gear and Acme screw units are inherently "self locking" because of the locking angle cut on the gear teeth or screw thread.

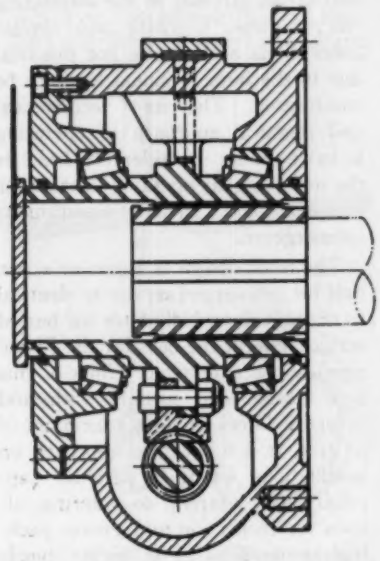

Fig. 1. NOTE HUB of steel which allows the hub to be splined internally to receive the butterfly valve shaft.

Quite often the torque output of a gear or screw unit is of such a high value that additional mechanical advantage must be added to the unit if the input torque is to be kept to a minimum. For this purpose an additional gear case is added to the main gear housing at the input shaft. This gear case contains a spur gear set with a ratio such that the required mechanical advantage is obtained. Another application for the spur gear set, apart from mechanical advantage, would be the "slowing down" of the operator by simply requiring more turns of the handwheel to close the valve. An illustration of a typical spur gear attachment is shown in Figure 6. Adding a spur gear set for the purposes of increasing operating torque should not be carried to extremes. When a valve has been fully closed, the stops in the gear housing stop all motion. An over-zealous valve operator may want to "wedge the old valve tight" and cause serious wear or galling of the screw or gear on subsequent operations.

A bevel gear attachment on a gear case serves the same function as the spur gear case attachment but in addition it changes the relative positions of the input shaft and the worm or screw. Where the spur input shaft still is parallel with the main worm gear shaft the bevel gear attachment input shaft is at 90° to input of the worm gear shaft as illustrated in Figure 6. This attachment is particularly useful for valves located in valve vaults. The valve can be installed with the valve shaft in a vertical position and the operating nut would be in a vertical position for operation from a street box. The vault size required therefore need only clear the valve flanges. With the spur gear attachment, the valve shaft would have to be horizontal in order to have the AWWA nut in a vertical position. In general the bevel gear addition is useful for difficult "laying in" applications in addition to being useful to obtain mechanical advantage.

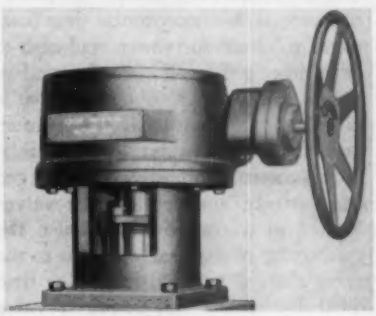

Fig. 2. A HANDWHEEL type typical of worm gear units.

Some more rare additions to manual operators might be mentioned briefly. If it is advantageous to manually operate two valves in unison with one handwheel a simple method is to have one gear reducer with an input shaft on both ends of the worm. The second valve operator shaft is then coupled to this extra shaft on the first gear reducer. Operating the handwheel on the first unit will operate both valves in unison and in phase or 90° out of phase as required. A second method of operating both valves with one handwheel is the use of a mitre box drive as shown in Figure 7. In general, for special variations of this type it is best to consult with your valve manufacturers engineers for a recommendation.

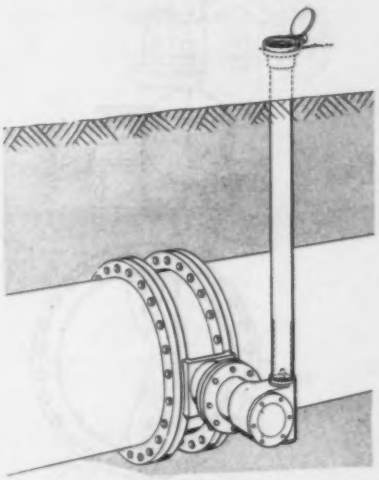

Fig. 5. TYPICAL ILLUSTRATION of a buried valve.

Operator Modifications—Special Applications

For distribution mains, the butterfly valve is suitable for completely buried lines. However, certain modifications to the gear unit are required. The indicator arrow is removed and a stationary cover plate seals off the gear unit. The cover on the input shaft of the gear unit, whether it

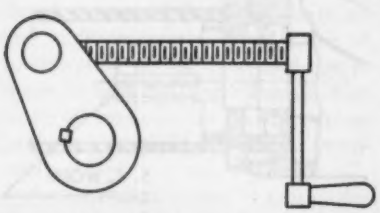

Fig. 3. ONE TYPE of screw and lever operator.

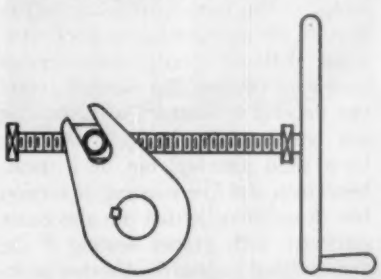

Fig. 3A. A TRAVELING nut unit with the nut engaged with the lever by means of the roller bearings.

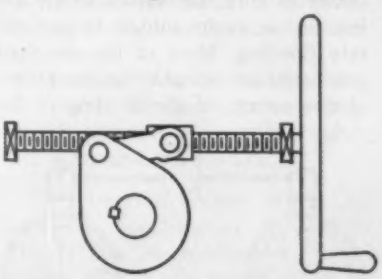

Fig. 4. A WIDELY USED operator consisting of a traveling nut and connecting to the lever by means of an intermediate link.

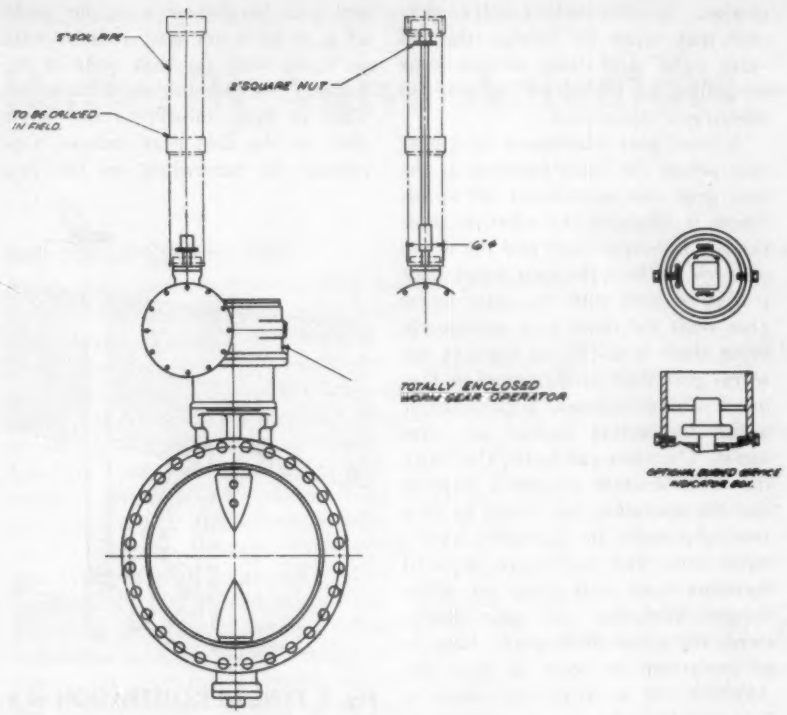

Fig. 6. A TYPICAL spur gear attachment.

be standard or with a spur or bevel attachment, is placed with a special cover which has a cast raised boss as shown in Figure 8. This raised boss is used to guide a 5" soil pipe to keep the soil pipe centered around the input shaft and provides the access necessary for operating the butterfly valve with a tee wrench. The entire gear case and valve assembly are of high strength design capable of withstanding the most adverse earth loads and ground water pressures. Many successful installations have proved the merit of completely burying butterfly valves used for distribution main service and similar applications.

In discussing gear units for submerged service, it is proper at the outset to eliminate valves which are installed in vaults subject to periodic rain flooding. Most of the standard gear units are suitable for conditions of this nature. If the flooding of the vault extends over any abnormal length of time, a good precautionary measure is to remove the gear case cover to check for water, and also to add new grease if necessary. For valves completely submerged, it is quite common to have the manual gear unit above water level. This is only practical for valves submerged at relatively low depths. For valves located at a considerable depth, the connecting of the gear operator to the valve shaft is very difficult. The first difficulty is the full required valve torque must be transmitted through the connection, since there is no gearing between operator and valve shaft. This leads to rather heavy bar (in most cases heavy tubing) not so much from the standpoint of stress in this member, but mainly due to strain in the form of angular deflection of the connecting member. Angular deflection can create serious problems because the butterfly disc can develop a "flutter" with the disc not connected to its gear operator by a rigid member, but by a member which acts like a spring or torsion bar. Angular deflection can also cause difficulty with proper seating if the "wind up" is excessive. Another problem in connecting gear operators located above waterline, to valves which are submerged, is that the valve shaft axis must be perfectly in line with the operator output axis. The reason for this is that any misalignment will create an eccentricity which will wear the valve and operator bearings and also create stresses in the connecting rod or tube. U-joints and similar connections are usually not practical due to the high torsional loads to be transmitted. The most economical and practical approach to operating a valve under considerable head is the use of a gear operator suitable for complete and virtually continuous submergence.

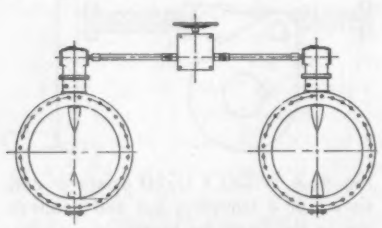

Fig. 7. A MITRE box drive.

The basic design of a gear or screw unit for submerged service is identical to the unit described above for buried service, except the boss for the 5" soil pipe can be eliminated. Units of this type design can usually withstand pressure forces up to a maximum of 65 feet. It is a practical approach on installations where a periodic (approximately yearly) de-watering, allows for inspection and grease packing as required. For higher heads or more critical installations, a "pressurized" gear unit is recommended. Pressure in the gear case is maintained by a column of oil of specific gravity approaching 1.0, with the reservoir for the oil being located above water level. A sight glass gives visual indication of whether oil is leaking out of the gear unit thru a damaged seal. Connecting the oil reservoir can be directly by an oil line to the gear case, or by means of a pipe connecting directly to the gear unit at the input shaft area. The extension of the input shaft passes through the center of this pipe, on up to the operating deck above. This pipe need not be overly large since the connecting shaft, driving the gear reducer, can now be fairly small in diameter due to the mechanical advantage of the gear reducer. A number of successful installations of this type

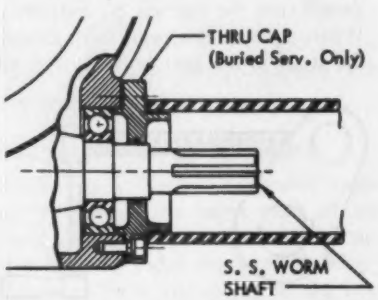

Fig. 8. A SPECIAL COVER which has a cast raised boss.

have been in operation for several years. The earliest and most noteworthy are the Stone Canyon and San Fernando reservoir installations of the Los Angeles Department of Water and Power where intake tower valving is operated with gear operators completely submerged and gear

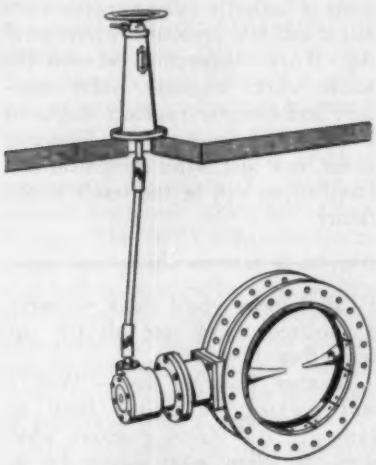

Fig. 9. A FLOORSTAND drive shaft.

cases pressurized. The use of submerged gear or screw operators is a sound design approach to operating a submerged butterfly valve, provided the economics of the various factors involved point to this solution.

Operator Extension Devices

Quite often the point of operation of the butterfly valve and the valve itself are some distance apart such as in submerged units. One of the most common devices used in these cases is the floorstand drive as shown in Figure 9. The floorstand drive shaft is connected to the worm gear reducer by means of an extension stem and two universal joints. The universal joints serve the function of compensating for any field misalignment of floorstand output shaft and gear reducer input shaft. The floorstand has an indicator arrow to show valve position and can also be equipped with a handwheel locking device. The floorstand is normally a direct drive and does not introduce any additional ratio in the drive. A modification of the floorstand can be made to have the stand also function as an oil reservoir for the pressurized gear case assembly described previously.

An extension bonnet is quite often useful in applications where it is desirable to have the gear or screw operator at some distance from the valve itself. The extension bonnet is shown in Figure 10 and can be used for buried valves to bring handwheel above grade, to bring operator up to operating deck elevation, or to prevent interference with other equipment by moving the operator further from the butterfly valve. The use of an extension bonnet above lengths of 18 to 20 feet is not recommended as a general practice since the reflection due to torsional loads in the connecting members creates the same difficulties of disc "flutter" and improper seating mentioned.

The direct torque drive shown in Figure 11 might be mentioned briefly. This assembly has the gear or screw operator mounted on a floorstand and full valve torque is transmitted directly to the valve shaft by a tube (commonly referred to as a "torque tube"). This method of operation is quite useful for installations where manual units are originally specified but future plant automation would require electric motor operation. Most gear and screw units are adaptable to motorizing after installation therefore the torque tube drive is required, since a submerged motorized unit is not practical.

Many other variations of operator extensions are available which include extended input shafts, mitre box arrangements, angle floorstands etc. For any special applications of this type it is best to consult an engineer of your valve manufacturer for a recommendation.

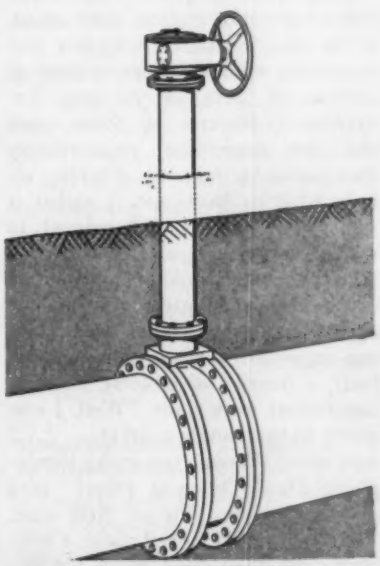

Fig. 10. THE EXTENSION bonnet.

Factors Governing Operator Selection

In all of the foregoing sections the matter of "output torque" was only touched briefly. This output torque represents the torsional output of a

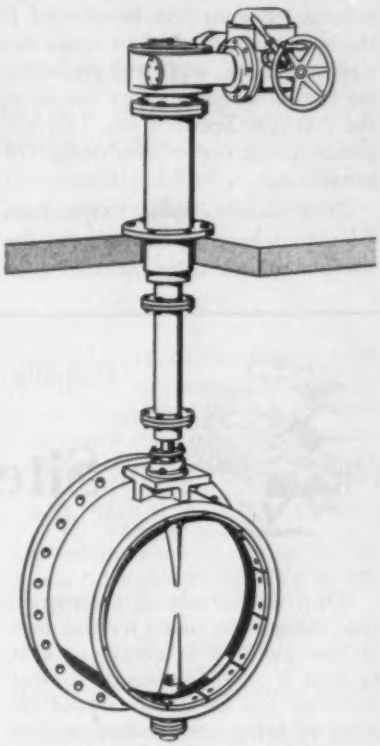

Fig. 11. THE DIRECT torque drive.

drive unit required to overcome the torsional resistance of a butterfly valve. This torsional resistance consists mainly of the following:

A. Seating torque—the torque required to create the necessary displacement of rubber to effect tight shutoff at rated pressure.
B. Fluidynamic torque—the torque needed to overcome the tendency of the butterfly valve to move closed when in a flowing stream—commonly referred to as to the aerodynamic or lift effect.
C. Bearing friction torque—the torque necessary to overcome the friction between the valve shaft and valve bearings.

The American Water Works Association Specification C 504-58, Table 8 lists the recommended torque ratings of butterfly valves under the most adverse operating conditions. For these conditions, the gear or screw unit for manual operation of

the butterfly valve, is simply chosen to equal or exceed these values. In the development of Table 8 of C 504-58 the operator ratings were chosen mainly for distribution main or "line break" service. For less severe design criteria, economy can be effected if the operators are sized to actual design conditions, while still maintaining the conservative safety factors of the AWWA Specification. This approach avoids costly "over-design" of installations.

Other factors beside torque considerations have an influence on the selection of manually operated gear or screw operators. One of the factors is that the gear or screw set, or special devices attached thereto, shall form a "self locking" or "not self-winding" unit. Another factor is that the manual effort to operate the butterfly valve should be kept to the minimum of what one man can reasonably exert. The days of "valve teams" or crews being sent out to operate some of the older valve types can thus be avoided. Closing speed of manual operators should also be considered, as well as the various installation configurations available.

Closure

The data in the foregoing article are by no means complete but were meant to point up some of the more important aspects of manual operators as related to butterfly valves. With the progress being made in the water works industry today, new applications of butterfly valve equipment are found and new problems require solving. If the cooperation between the water works engineer, valve engineer and operator engineer displayed over the past dozen years or so is any index, new and better equipment and installations will be the result in the future.

Partially Oriented on . . .

Site Conferences

When the horrors of a construction site get too much for one man to bear alone, it is always possible to hold a Site Conference so that the woes can be spread around instead of being concentrated on one person—me. At a site conference the Boss Engineer sums up the situation in hand (or out of hand), listens to various opinions (if any) available, and then issues crisp, clear directions as to how to go on from there. After this, the slaves can go back to their jobs knowing exactly what to do (and sometimes why) and the Boss Engineer can go back to fishing and/or golfing and/or shooting and/or writing. That is the theory, on which it is now opportune for a practising field engineer (me) to report.

In the first place it might as well be made clear that no *regular* site conference is possible at all. No known construction site is regular enough to have them. Regularity is a term that applies only to professions like accounting where it is always the day before pay-day (panic), or the day after pay-day (greater panic), or not pay-day at all (somnambulance). On a construction site things are either now gone wrong, still gone wrong, or forgotten. Thus, of the two sorts of jobs to be discussed at site conferences—namely, those we are stuck with right now and those we aren't—a conference about the first is superfluous (even if there was time), and a conference about the second is premature. Every one is sick of discussing present problems and no one cares a fig about future problems. Sufficient unto the day . . . etc., without the boss holding a special site conference about it all.

At times, however, the forward-looking Boss Engineer may sometimes run out of ideas to think about, or he may feel that Things are just happening without a master mind in control of them, or he may feel vindictive. In any of these cases the site conference extraordinary may serve a purpose. Feeling so, I decided to have one. I called it for Noon because that seemed to me an effective part of the day when everyone should be awake.

Whether noon gives a feeling of appropriateness I cannot say. Having suggested noon as the operative hour, a number of nibbling counter-suggestions were made. "Well, I was going to take levels over at . . . . ." says one. "Weren't you going to telephone Head Office at noon?" says another. (I was, but let them wait. They can't get annoyed about a telephone call they don't know I'm going to make. Judging by the last time I called them, you'd think we were a misfired rocket for all the interest they show in us).

Another blatantly says—"Well I was g o i n g in to the bank to cash . . . . ." (Good gracious, what does the fellow want money for in a place like this? But if he is going in I might as well go with him . . . .). So I settled for "about twenty past two, or when W. gets back from . . . ."—a poor substitute for *High Noon*. It seemed to me that a site conference starting off in this inauspicious manner might not prove exceptionally brilliant. I was right.

I suppose the worst handicap the Conference laboured under was that I had forgotten to think up what it should be about. A conference (like a Think Meeting, or Study Weekend) should have a Theme. It is not easy to think up a theme all by yourself with half a dozen people standing around waiting for you to think it up. After a while I was inspired to ask W. for a report on what he had been up to, how far he had got up to in it, and when he might be coming out of what he had been up to.

Of course we all knew perfectly well what W. had been up to for some weeks. We also knew (because of the words he kept using about the office from time to time) what he thought about what he had been up to. He gave us a pot-pourri of facts and opinions; sometimes he gave the facts first and the opinions after, but sometimes he gave the opinions first and forgot to give the facts. I forebore to acquaint him with

CONTINUED ON PAGE 236

New Platinum Electrode System Measures DO and BOD

by J. D. EYE, L. H. REUTER and K. KESHAVAN, respectively
Assoc. Prof. Sanitary Engr, University of Cincinnati; Lieut., U.S. Army; Graduate Student, Sanitary Engr., University of Cincinnati

■ DISSOLVED OXYGEN (DO) and Biochemical Oxygen Demand (BOD) measurements have assumed a position of utmost importance in waste treatment and water pollution control. The dissolved oxygen test gives a measure of the ability of a water to support organisms which utilize free oxygen. The BOD determination is a measure of the amount of oxygen that will be used by bacteria as they decompose the organic components of wastes. The BOD test has become one of the most significant parameters for characterizing the pollutional aspects of organic wastes.

The standard test for dissolved oxygen (Winkler Test), as outlined in Standard Methods[12], consists of adding appropriate chemical reagents to a sample of water and measuring the chemical equivalent of dissolved oxygen present. The BOD test consists of measuring the initial dissolved oxygen level of an appropriately diluted sample and the oxygen level at the end of a stated period of time, usually five days. Only one dissolved oxygen test can be made on an individual sample. A BOD measurement requires several dissolved oxygen determinations; therefore, a large number of samples is required if many points are needed on a BOD versus time curve (Figure 1).

The standard tests for dissolved oxygen and BOD have many shortcomings and disadvantages which have not been overcome fully from a practical standpoint. Hence, investigators have devoted much time and effort to the development of more appropriate means for measuring these important quality characteristics. One of the most fruitful approaches has been the application of the polarographic principle to the analysis for dissolved oxygen.

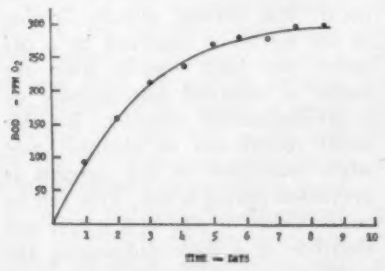

Fig. 1. TYPICAL BOD versus time curve for domestic sewage.

Polarographic Systems

General

A typical polarographic system consists of an electrolysis cell, a small highly polarizible electrode, a large non-polarizible electrode, a source of applied potential and a means for measuring current. It has been shown that as the voltage applied to a polarographic cell is increased, the amount of current flowing in the system at a particular EMF range will increase rapidly for a small change in applied potential whereas at other EMF ranges only slight variations in current will be noted for large increases in applied voltage (Figure 2).

Professor Jaroglav Heyrovsky, of Charles University, in 1922 investigated these peculiar current fluctuations and developed instruments for automatically recording the current versus applied potential. He concluded that the voltage necessary for electrolysis indicated the nature of the reacting substances, and that the current flowing is proportional to the concentration of the reacting substance.

Measuring Dissolved Oxygen by Polarographic Techniques

Investigators have found that dissolved oxygen in an electrolytic solution is easily reduced and produces a two-wave polarogram. Kolthoff and Lingane[7] explained that the first wave (Figure 2) is caused by the reduction of oxygen to hydrogen peroxide as indicated in the following equation:

$$O_2 + 2H^+ + 2e^- = H_2O_2 \text{ (Acid Solution)}$$

or

$$O_2 + 2H_2O + 2e^- = H_2O_2 + OH^- \text{ (Alkaline Solution)}$$

The second wave is due to the reduction of hydrogen peroxide to water or hydroxyl ion:

$$H_2O_2 + 2H^+ + 2e^- = 2H_2O \text{ (Acid Solution)}$$

or

$$H_2O_2 + 2e^- = 2OH^- \text{ (Alkaline Solution)}$$

In operation, the applied potential must be sufficiently low to prevent the discharge of hydrogen at the electrode surface. While oxygen can be reduced at two distinct potential ranges, operation in the lower range will give the most satisfactory results.

The actual current that can be obtained from a polarographic system is determined by the rate of supply of the substance being reduced at the cathode from the body of solution. The rate at which oxygen molecules diffuse to the cathode is dependent upon the concentration gradient between the electrode surface and the body of solution. From a practical standpoint, therefore, in dissolved

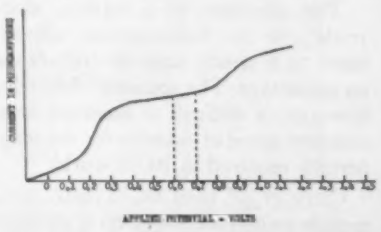

Fig. 2. TYPICAL POLAROGRAPHIC curve for oxygen.

oxygen and BOD analysis, the current flowing in the electrode system at constant temperature and viscosity is a function of the concentration of dissolved oxygen in a sample being analyzed.

Many investigators have attempted to develop a working polarographic system for continuous dissolved oxygen measurements. Spoor[8] developed a procedure for utilizing a dropping mercury electrode system for the continuous measurements of dissolved oxygen in flowing water. The water had to be maintained at a very low velocity, however, to prevent interference with the mercury droplets.

Rotating and stationary solid-electrode systems have been used for dissolved oxygen measurements and in many cases these have been superior to the dropping mercury arrangement.

Kolthoff and Lingane[7] showed that a rotating platinum microelectrode is perferable to a dropping mercury electrode for measurements of low oxygen concentrations because the diffusion current is much larger with a rotating electrode.

Allen and Powell[1] found no shift in potential for a rotating platinum electrode during reasonable lengths of operation. They obtained a linear relationship between the oxygen concentration and diffusion current although very close temperature control was required.

Giguere and Lauzier[5] investigated all types of electrode systems. They found that the rotating and stationary types were extremely temperature-dependent as well as sensitive to the type of electrolyte used in the cell.

Warshowsky and Schantz[13] used a rotating platinum electrode to determine the DO of aerated and agitated bacteria culture media containing actively respiring organisms. They also made DO measurements on salt solutions, getting results which agreed with the values as determined by the Winkler procedure.

The advocates of a rotating electrode cite its instantaneous adjustment to a steady state of current as an advantage. The spinning electrode, however, is difficult to maintain at a constant speed of rotation for the long periods required in BOD work.

Clark *et al*[3] used an oxygen- permeable membrane cover on a stationary platinum electrode to measure oxygen tension in blood. The membrane, although permeable to oxygen, was much less permeable to other dissolved materials. Clark, however, used the membrane to separate the measuring and reference electrodes, thereby causing high impedance characteristics for the system. Clark[4] later improved the system by combining the platinum-reference electrodes behind the membrane.

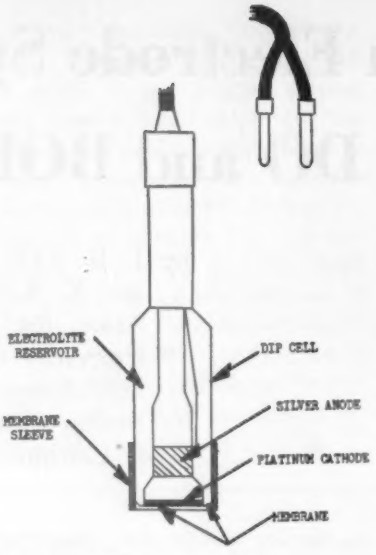

Fig. 3. ELECTRODE CELL.

Ingols[6], using a stationary platinum electrode, a calomel half-cell electrode and an alternating charge, determined the DO of samples of natural water and sea water. The electrode, however, would not work well with sewage. Certain enzymes in the sewage were suspected as being responsible for the difficulties.

Lynn and Okum[8], using a rotating platinum wire electrode, found that the speed of rotation beyond 500 ppm did not affect the measured current. Working with DO values ranging from zero to 36 ppm, they did not obtain a linear calibration curve of current versus DO concentration.

Watanabe and Leonard[14] reported on the use of a modified Clark electrode consisting of a plastic covered, stationary, combination platinum-reference electrode system. Current was found to be directly proportional to the area of the platinum electrode and inversely proportional to membrane thickness. The electrode was extremely temperature-dependent.

Ough and Amerine[9] found that the Clark electrode was suitable to measure the oxygen concentration in wines.

Carritt and Kanwisher[2] attempted to construct a temperature compensated plastic covered electrode. While their work was not completely successful, the errors resulting from changes in temperature were greatly reduced.

Sawyer[10] studied the Clark electrode and its application to oxygen and other gaseous measurements.

Biochemical Oxygen Demand Measurements by Polarography

General Description of Electrode System

The electrode system* used in the present study consists of a platinum cathode covered with a polyethylene membrane of two to four mils in thickness. The platinum cathode and silver anode are connected by a supporting electrolyte of potassium chloride. The electrodes are conveniently housed in a glass dip cell (Figure 3).

In operation, the polarographic cell is immersed in a sample to be analyzed for dissolved oxygen. A potential of 0.6 to 0.7 volt is supplied by a standard dry cell (Size D Flashlight Battery). At this operating voltage, dissolved oxygen is the chief substance that will be reduced at the cathode surface. Other materials can be reduced at this voltage, but, in general, they will not pass through the plastic membrane covering the cathode. As indicated earlier, the current flowing in the system is a function of the number of oxygen molecules being reduced at the cathode surface. This number in turn is directly related to the concentration of oxygen molecules within the body of the liquid; hence, the current is a measure of the concentration of oxygen in solution.

If oxygen measurements are to be made continuously, it is necessary the sample be stirred constantly so plating of the electrode surface does not occur. The current actually flowing in the system is amplified by a pH meter and read directly from the meter or recorded automatically on a potentiometric recorder. Reliable BOD results can be obtained only when reaeration of the samples is prevented during a test. This can be accomplished by placing a sample and electrode in a flask and sealing the

*Electrode system produced by Beckman Instruments, Inc., Fullerton, Calif.

flask properly. The sample being analyzed can be agitated with a magnetic stirrer.

Components of Electrode System

1. Plastic Cover for Electrode: The plastic membrane covering the cathode surface is an extremely important component of the polarographic cell. While the membrane must be permeable to dissolved oxygen, it should not be permeable to other ions which can be reduced at the operating voltage specified. The membrane also serves the important function of keeping the internal electrolyte in contact with the anode and cathode. Several materials have been utilized as a cov-

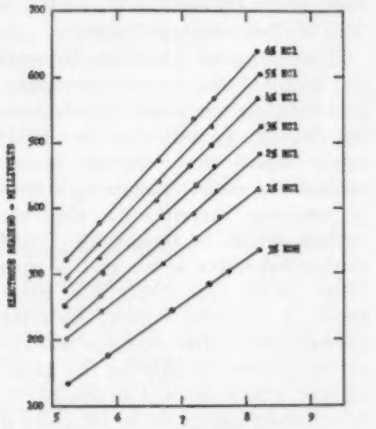

Fig. 4. EFFECTS OF INTERNAL electrolytes or dissolved oxygen measurements.

ering for the electrode surface, but, in general, polyethylene film appears to give better results and fewer difficulties than any other type of plastic film investigated.

The greatest difficulty noted in using polyethylene film is the fact that the thickness varies considerably for a standard gauge material. From the standpoint of sensitivity, a polyethylene film two mils thick is ideal, but because of the variation in thickness of a two mil film, reproducible results cannot be obtained. A film four mils thick likewise is variable in thickness, but the effect is much less noticeable than with a two mil film. The sensitivity and precision of a four mil membrane are not so good as for a two mil film, but the overall results for oxygen measurements are as good as those obtained by the standard chemical test. Polyethylene film three mils thick falls somewhere between the two and four mil thicknesses in operating characteristics and is probably the most satisfactory type to use for most oxygen measurements.

An attempt was made to use Teflon film because this material is more uniform in thickness than polyethylene. The sensitivity and precision of a Teflon covered electrode was far superior to a polyethylene covered system. Unfortunately, a long period of time was required for a Teflon covered electrode to reach stability, and the results seemed to change somewhat from day to day.

2. Internal Electrolyte: Several possible internal electrolytes can be used as a junction between the cathode and the anode. In this particular study, dilute solutions of potassium chloride and potassium hydroxide were investigated. In operation, it is important the reference electrode maintain a potential independent of the current flowing through the cell. Some investigators have recommended the use of potassium hydroxide rather than potassium chloride for the electrode system. The writers found that both electrolytes are satisfactory. A straight-line relationship was obtained between current flow and dissolved oxygen level although the actual values of current observed were dependent upon the strength of the supporting electrolyte (Figure 4).

Operation of Electrode System

1. Calibration; Before an electrode system can be used for routine dissolved oxygen measurements, a calibration curve must be established.

One of the basic difficulties in preparing a calibration curve for an electrode is the fact that no primary dissolved oxygen standards are available. It becomes necessary, therefore, to prepare a series of secondary standards by aerating samples of water for varying periods of time and determining the actual oxygen content of these samples by a standard chemical test. The calibration of the electrode, therefore, is entirely dependent upon the results obtained from a standard chemical test for dissolved oxygen.

At the operating voltage indicated, and at constant temperature, a linear relationship was observed between the current, or pH meter output, in millivolts, and the oxygen concentration (Figure 5). In practice, the precision and accuracy of the electrode procedure for measuring dissolved oxygen cannot be determined completely because of the fact that the results of this procedure must be

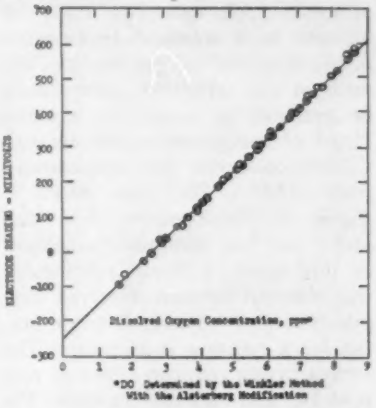

Fig. 5. CALIBRATION CURVE for electrode system.

judged on the basis of results obtained by a chemical test. It is possible, however, to measure the reproducibility of the electrode procedure, and in this study the reproducibility was found to be equal to that of the standard chemical test (Table 1).

Table 1

Reproducibility Data by the Winkler and Electrode Procedures

	Dissolved Oxygen Concentration in ppm*	
	By Winkler Method	By Electrode
Series A		
Sample No.		
1	4.7	4.9
2	4.9	4.9
3	4.8	4.8
4	4.9	4.8
5	4.8	4.8
Series B		
Sample No.		
1	7.6	7.5
2	7.7	7.6
3	7.5	7.6
4	7.6	7.5
5	7.5	7.5
Series C		
Sample No.		
1	8.0	7.9
2	8.1	8.0
3	8.0	8.1
4	7.9	7.9
5	7.9	7.9
Series D		
Sample No.		
1	5.9	5.7
2	5.7	5.8
3	5.7	5.7
4	5.8	5.8
5	5.7	5.7

*Ten dissolved oxygen bottles were filled by siphoning water from the same sealed container for each series of data. Five of the samples were selected at random to be analyzed by the Winkler Method and the other five were analyzed by use of the electrode cell.

2. Temperature compensation: The temperature dependency of the electrode system imposes severe limitations on the application of this method to routine dissolved oxygen measurements. All samples must be brought to a standard temperature before dissolved oxygen readings are made or else calibration curves must be available to cover the working range of temperatures encountered. Calibration curves for temperatures from 13°C to 28°C are shown in Figure 6. These curves show that under the test conditions employed in this study, a linear relationship was obtained between dissolved oxygen concentration and electrode output for a constant temperature. The curves have a common origin at zero ppm DO and vary only in slope. The increase in slope per degree C increase in temperature is approximately constant for the range of 13°C to 28°C.

In routine BOD analysis, all samples are maintained at a constant temperature throughout the period of a test. Temperature compensation, therefore, is not necessary since the electrode system operates continuously under constant temperature conditions.

3. Initial Stabilization of Electrode System: When a cell is first immersed in a sample to be tested, a short period of time must elapse before a stable reading can be obtained. With a polyethylene membrane covering, a stable reading is achieved in one to three minutes. The period of stabilization is influenced by the rate at which oxygen molecules are brought from the body of the solution to the electrode surface. Since the current is proportional to oxygen concentration only under steady state conditions, stirring the sample hastens the process of equilibrium and greatly shortens the stabilization period.

4. Zero-Drift: In using an instrumental procedure for the continuous measurement of oxygen levels, for a period of five days, it is important that the system exhibit a low zero-drift. If the zero-drift occurs, it must be taken into account and its effect on the overall readings eliminated.

A detailed study was made of the zero-drifts of the dissolved oxygen electrode system. For periods up to seven days, the system was extremely stable and would not present a problem from this standpoint (Table 2).

Table 2
Zero-drift Study Using Varying Concentrations of Internal Electrolyte and Samples with Different DO Concentrations

Time	Dissolved Oxygen in Parts per Million	
	By Electrode*	By Winkler Method
Internal electrolyte—3 per cent solution of potassium chloride		
Initial Reading	8.1	8.1
1 day	8.1	8.2
2 days	8.1	8.1
3 days	8.1	8.1
4 days	8.1	8.2
5 days	8.1	8.1
6 days	8.1	8.2
7 days	8.1	8.1
Internal electrolyte — 1 per cent solution of potassium chloride		
Initial Reading	7.7	7.7
1 day	7.7	7.7
2 days	7.7	7.8
3 days	7.7	7.8
4 days	7.7	7.7
5 days	7.7	7.9
6 days	7.7	7.7
7 days	7.7	7.7
Internal electrolyte — 5 per cent solution of potassium chloride		
Initial Reading	7.9	8.0
1 day	7.9	7.9
2 days	7.9	7.9
3 days	7.9	7.9
4 days	7.9	8.0
5 days	7.9	8.1
6 days	7.9	7.9
7 days	7.9	7.9

*All tests conducted at 20°C. and similar operating conditions. All tests were on distilled water samples.

The small differences noted in Table 2 between the DO levels as measured by the electrode system and the Winkler procedure are within the limits of reproducibility of the standard Winkler test.

A zero-drift may occur if the same membrane and internal electrolyte are used for long periods of time. Apparently, the membrane tends to undergo some deterioration if exposed to mechanical and bacterial action for prolonged periods of time and the composition of the internal electrolyte also will change with respect to time.

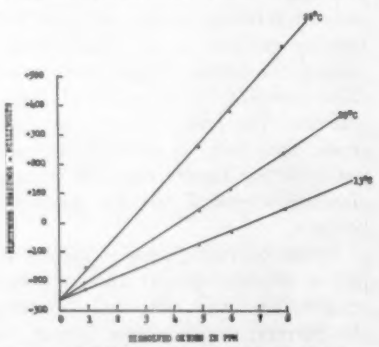

Fig. 6. EFFECT OF TEMPERATURE on electrode reading.

Battery deterioration, during extended periods of continuous operation of the electrode system, is the major cause for zero-drift. It is possible to prevent zero-drift from battery aging by replacing the battery at frequent intervals or by re-standardizing the electrode system before dissolved oxygen measurements are made. In most cases, the battery will have to be replaced after 10 to 15 days of continuous operation.

5. Cleaning of Electrode System: For ordinary dissolved oxygen measurements, the electrode system must be cleaned periodically. In BOD work, where the electrode is immersed in a sample containing actively respiring bacteria, the electrode surface should be thoroughly rinsed in distilled water at the end of each 5-day BOD run. Since the silver anode is in direct contact with the internal electrolyte, deposits will occur from time to time on the anode surface. These deposits generally can be removed satisfactorily by soaking the electrode in thiosulfate followed by soaking and rinsing in distilled water.

In this study, thiosulfate cleaning was used after three or four months of continuous operation.

Experimental BOD Measurements

A special adapter assembly (OM-2 Kit, No. 18900,* using a flashlight battery (Size D) as the source of applied potential, was coupled to an electrode cell and a Zeromatic pH Meter. Voltage readings were read on the millivolt scale of the pH meter. The BOD samples being analyzed were prepared in accordance with procedures outlined in Standard Methods[9]. A sealed, 1000 ml Erlenmeyer flask, maintained at a constant temperature, housed the sample and electrode cell. A thermometer was used to measure the temperatures of the sample at the time each voltage reading was recorded. A magnetic stirring device provided a homogeneous system and a continuous

*Beckman Instruments, Inc., Fullerton, Calif.

flow of oxygen molecules past the platinum electrode surface.

Nineteen 5-day, 20°C BOD tests were run using "grab" samples of sewage from the Little Miami Sewage Treatment Plant and the Mill Creek Interceptor Sewer of Cincinnati. One, two, and three per cent dilutions of sewage were used. The 5-day, 20°C BOD's of the sewage ranged from 180 to 325 ppm.

In these tests, two sets of dissolved oxygen data were obtained. One set of samples was analyzed by the standard chemical test while corresponding samples were analyzed with a stationary platinum electrode system.

The Winkler procedure was constant for all BOD tests, but the operating conditoins for the electrode system were varied to provide specific information on the reliability of the electrode procedure, the need for frequent standardization of the electrode system, and the effects of battery deterioration on electrode response.

Discussion of Results

Representative data accumulated from the BOD studies are listed in Table 3. These data indicate that with proper laboratory control, good correlation can be achieved between the standard BOD test and the electrode procedure. Of the nineteen series of BOD tests performed for this study, the maximum 5-day deviation between the dissolved oxygen concentration of a sample analyzed by the electrode method and a corresponding sample analyzed by the standard chemical test was 0.7 ppm. A majority of the 5-day deviations were between 0.2 and 0.5 ppm.

In almost all cases, higher BOD values were obtained with the electrode procedure than with the standard Winkler procedure. Two possible explanations for these higher values are: mechanical stirring of a sample maintains better contact between the organic matter and the bacteria and thus may give a higher BOD removal than can be achieved in the static system used for routine BOD analysis; the second possibility is that the organisms can oxidize certain plastic components of the electrode system and thereby give an apparent increase in total BOD. Current studies indicate that the second factor is quite significant with certain types of organic wastes and biological systems. It is essential, therefore, that the materials used in the construction of an electrode system be relatively inert to biological oxidation.

Table 3

BOD Measurements by Standard Winkler and by Electrode Procedures

Sample No.	Series No.	Test Method	TIME IN DAYS 0	1	2	3	4	5	5 Days DO PPM	5 Days BOD PPM
			Dissolved Oxygen Concentration — PPM							
A	1	Winkler	7.6	6.6	5.5	4.0	3.2	2.7	4.9	245
		Electrode	7.6	6.4	5.2	3.6	2.6	2.2	5.4	270
B	1	Winkler	8.0	7.3	6.7	6.2	5.5	5.1	2.9	290
		Electrode	8.1	7.2	6.5	5.9	5.2	4.7	3.4	340
A	2	Winkler	8.0	6.1	3.9	2.5	1.6	1.2	6.8	227
		Electrode	7.8	5.7	4.0	2.2	1.3	0.8	7.0	233
B	2	Winkler	7.6	5.0	2.9	1.8	1.3	0.9	6.7	223
		Electrode	7.4	4.7	2.6	1.5	0.8	0.4	7.0	233
C	2	Winkler	7.6	7.0	5.9	5.1	4.2	3.3	4.3	215
		Electrode	7.7	6.9	5.7	4.7	3.9	2.9	4.8	240
D	2	Winkler	7.4	6.5	5.6	4.8	4.1	3.6	3.8	190
		Electrode	7.5	6.3	5.4	4.3	3.7	3.2	4.3	215
E	2	Winkler	7.8	6.5	4.9	3.7	2.9	2.3	5.5	275
		Electrode	7.9	6.4	4.6	3.3	2.6	1.9	6.0	300
A	3	Winkler	8.1	7.1	6.3	5.6	5.0	4.5	3.6	180
		Electrode	8.1	7.3	6.6	5.6	5.0	4.3	3.8	190
B	3	Winkler	8.0	6.8	5.9	5.0	4.4	3.9	4.1	205
		Electrode	8.1	6.7	5.7	5.1	4.1	3.6	4.5	225
A	4	Winkler	8.1	7.5	7.0	6.3	5.8	5.4	2.7	270
		Electrode	8.3	7.4	6.7	6.0	5.6	5.2	3.1	310
B	4	Winkler	7.8	6.5	5.2	4.2	3.4	2.7	5.1	255
		Electrode	7.6	6.5	5.3	4.0	3.1	2.4	5.2	260
A	5	Winkler	7.9	6.0	4.6	3.3	2.5	1.8	6.1	305
		Electrode	8.0	6.3	4.8	3.3	2.7	2.1	5.9	295
B	5	Winkler	7.8	6.2	4.6	3.5	2.4	1.9	5.8	290
		Electrode	7.7	6.0	4.2	3.2	2.2	1.6	6.1	305
A	6	Winkler	8.1	6.4	5.3	4.1	3.2	2.6	5.5	275
		Electrode	8.3	6.3	5.0	3.8	2.9	2.3	6.0	300
B	6	Winkler	7.7	6.6	5.5	4.5	3.7	3.0	4.7	235
		Electrode	7.6	6.2	5.2	4.1	3.2	2.5	5.1	255
A	7	Winkler	8.0	6.1	4.3	2.9	2.1	1.5	6.5	325
		Electrode	8.0	6.0	4.2	2.7	1.9	1.2	6.8	340
B	7	Winkler	7.7	6.6	4.5	3.0	2.5	1.9	5.8	290
		Electrode	7.7	6.3	4.3	3.1	2.6	2.0	5.7	285

Series No. 1 was conducted with continous stirring of the sample. The instrument was standardized before each DO reading. A new battery was used for each BOD test.

Series No. 2 was conducted with continuous stirring of the sample. The instrument was standardized before each BOD test and the same battery was used throughout all BOD tests in the series.

Series No. 3 was conducted with the sample stirred only for a 15-minute period preceding readings. The instrument was standardized only before the initial DO reading. A new battery was used for each BOD test.

Series No. 4 was conducted with the sample stirred only for 15-minute periods preceding readings. The instrument was calibrated before each BOD test. The same battery was used for all BOD tests in the series.

Series No. 5—same as No. 4 except that instrument was calibrated only before the initial BOD test.

Series No. 6 was conducted with continuous stirring of the samples. The instrument was calibrated only before the initial BOD test. The same battery was used for all BOD tests.

Series No. 7—same as No. 4 except that a new battery was used for each BOD test.

The studies designed to check the need for frequent standardization of the electrode system showed that no appreciable drift would occur for periods of 10 to 15 days of continuous operation. As indicated in an earlier section, aging of the battery is the main cause of zero-drift. Frequent standardization becomes necessary if reliable results are to be obtained with a battery nearing exhaustion. In general, if the battery is replaced every 10 to 15 days, standardization will be necessary only when a new battery is installed.

Summary and Conclusions

The reported study indicates the feasibility of employing a plastic covered, stationary, platinum-electrode system for measuring the dissolved oxygen and BOD content of water and domestic sewage. The fact that any number of points on the BOD versus time curve can be obtained from single samples is of great value in routine laboratory studies. The

electrode procedure also offers the possibility of running long-term BOD tests on a single sample of waste.

From the experimental work on the application of a plastic covered stationary electrode system for DO and BOD determinations, the following conclusions were reached:

1. The electrode gives reproducibility of dissolved oxygen measurements comparable to that of the standard chemical (Winkler) tests.

2. The electrode system response is temperature-dependent. Since all BOD work is carried out at a constant temperature, temperature compensation is not required.

3. The electrode cell will operate satisfactorily with either potassium hydroxide or potassium chloride, in varying concentrations, as an internal electrolyte.

4. Zero-drift of the electrode cell is caused primarily by changes in the battery. This effect can be eliminated by frequent standardization of the system or by replacing the battery every 10 to 15 days.

5. A particular electrode will usually give a stable output in less than three minutes when taken from one environment to another.

6. Dissolved oxygen concentrations can be determined with a degree of accuracy comparable to that of the standard Winkler test at a particular temperature, provided the temperature is held constant.

7. The polyethylene film is satisfactory as an electrode membrane, and is seldom a cause for electrode cell errors. Membranes three or four mils in thickness are the most satisfactory.

8. In general, a thorough rinsing of the electrode with distilled water at the end of each 5-day BOD test is sufficient for routine BOD work. A more thorough cleaning and removal of deposits from the electrode will be required three or four times a year.

9. Certain plastic components of the electrode cell used in this study can be oxidized by bacteria. It is necessary that this error in oxygen utilization be eliminated by the use of materials which are inert to biological oxidation.

10. The constituents of the domestic sewage used in this BOD study did not interfere with electrode operation for periods of five days.

11. With proper control of operating conditions, continuous BOD analysis of domestic sewage can be made with the plastic covered, stationary platinum-electrode system.

Acknowledgment

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Site Conferences

Continued from page 230

the contents of the latest directive from Head Office, lest he acquire more opinions and less appetite for going on.

After that L. gave us his version of Parkinson's Reversed Law for construction sites—namely the more work you did, the more there was left over to do. He confirmed that he was still able to stand the strain of it all, though he did not know of any other person who could. It was G.'s turn next. G. considered it was an appropriate time to acquaint us with the detailed difficulties of his particular pastime, which diffculties would be unsurmountable but for the fact that he was giving them his undivided attention, the end result of which would be undoubted satisfaction all round with what would probably turn out to be the best part of the job. As we had no interpreter of Irish brogue handy we were not quite sure what he was talking about.

It occurred to me that we were not Forward Thinking enough, and I began to dwell upon the horrors yet to come. This was a wrong move. If the Boss Engineer was wavering in the face of the odds, then the assistant bosses were obviously tempted to put their heads into the nearest bins of small aggregate. I rescued these worst impressions by suggesting that I was merely putting these things forward so that Some Thought might be given to them by all and sundry in due course. All and sundry looked at their boots, and the ceiling, and no further business being on the agenda, the conference party shuffled out as if they had been attending a second feature film of poor quality they really hadn't meant to see.

From that experience I have gained some useful know-how in the art of holding site conferences. I may even hold another before we finish the job so that I can try out some new ideas, like asking people to bring pencil and paper with them so that they can note down things. Perhaps the best idea came to me soon after the conference when I sat down to sort out the piles of papers lying around on my desk. When I got

CONTINUED ON PAGE 247

Editorial

The Need is Great

The American Journal of Public Health recently spoke out Editorially (April, 1961) about continued opposition to community water supply fluoridation. Pointing out that 40 communities in 1960 voted against fluoridation, compared with ". . . only about a dozen that adopted the practice", the Journal said, "it is clear that the problem is a political one". If this is true ". . . it may be useful to help governmental units and health agencies to see whether the fluoridation issue cannot be dealt with by administrative action". Several suggestions are made which the Journal believes would enable further expansion of the fluoridation program.

Among the ideas submitted is that it might be possible to take a lesson or two from ". . . our public health ancestors . . .", who ". . . were not afraid to stand up and be counted, and they called a spade a spade". It is in this area of personal activity that all of us need to exert a maximum of fortiude. It is true that "on various ceremonial occasions we express our filial piety for . . . these ancestors who blazed trails into the unknown and did battle at the political level when necessary".

We do not wish to limit the exertion of personal fortitude to the expansion of the important fluoridation program. Included in a long list of objectives worth fighting for in our field are laws governing operator certification in states not now covered, forced action against producers of untreatable pollutants, or better yet, positive organization of research efforts to identify and render treatable those pollutants which might be troublesome. There are many examples over the last fifty years where knock-down drag-out conflicts arose over simple disinfection procedures. This long series of battles has virtually won the war against disease bearing water.

How many battles will be fought and won to raise the quality of water: to eliminate hardness, color, iron, manganese, detergents, endless organics, to deliver less than ambient temperature water, or to guard against drought, low pressure and distribution system loss? Will there be politics involved in stepping up waste treatment methods to include tertiary methods not now known, or devices developed to guarantee against malfunction, or operator lapse? One thing is certain: these and other factors will respond only to devoted and conscientious effort on the part of workers within this field, not from disinterested citizens, public or private, who are busily grinding their own miscellaneous axes.

The AJPH pointedly states the following:

> "What a particular community needs, what action it requires, must be decided locally. But public health people have a definite responsibility for leadership, for education, and to see to it that the welfare of the majority is recognized."

It is local leadership which, often lacking, can stimulate the necessary action to achieve goals, pass bond issues, obtain rate increases, destroy public apathy and increase awareness, establish high regard for the best water supply, best record of pollution abatement, and in general translate ideas into progressive action. The major technical associations point with pride to their historic leaders and founders, identify them with memorial awards and comment annually on their greatness. This is indeed as it should be. But who is making contributions of stature to which our filial descendents will point with pride? Who will be this generation's George Warren Fuller or Harrison Prescott Eddy? The need is great and the time is now.

V. W. Langworthy

RESEARCH PROGRESS REPORT

Measuring Coliforms in Water

by JOSEPH A. McCARTHY, Chief
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AUTHOR'S NOTE: This study, which includes an analysis of the discrepancies encountered with the use of the membrane filter and a proposed technique, is supported in part by a grant from the National Institutes of Health to the Massachusetts Health Research Institute.

Introduction

■ THE SPECIFIC AIM of this research project as submitted to the NIH was "to assess the possibility of obtaining results by the membrane filter technique which are statistically equivalent to the standard multitube technique for the estimation of the sanitary quality of water, using coliform bacteria as a parameter."

Our previously published data on this and related projects[1, 2, 3, 4] indicated quite conclusively that the lack of agreement reported between the membrane filter and the multitube technique is due to the inability of presently available media with the present technique to provide a uniform growth of all members of the coliform group resulting in uniform recognizable appearance within a convenient and uniform incubation period.

A procedure has been developed at the Lawrence Experiment Station, as a result of the work under the grant, which affords much greater and much more nearly uniform recovery of all the coliform types found in water samples than any combination of medium and technique previously tested. This has resulted from critical studies of the behavior of the various members of the group and particularly of their growth characteristics on various media.

Disadvantages of the One-Step Endo Broth Technique

The original membrane filter technique included an enrichment period followed by transfer of the filter to a selective medium for final incubation. Later, many media were proposed which were reported to provide satisfactory results in a simpler one-step incubation[6, 7, 8, 9]. There is, naturally, a preference for the simpler technique, but close scrutiny has shown the following inherent disadvantages in its use.

Suppressive Effect

The bacteria lodged on the surface of the filter are intimately bathed in the relatively high concentration of fuchsin and sulfite. This environment has been found extremely detrimental to the weaker coliforms, with actual kills of a large part of the species in a short period. Laboratory experiments demonstrate this effect[10].

To determine the suppressive effects of M-Endo broth[11] on coliform bacteria, we used the following laboratory procedure. Pure culture suspensions were prepared and a sizeable number of coliform bacteria were inoculated into full strength M-Endo broth. The initial coliform density ranged from 50 to 100 per ml, which is relatively equal to the count per unit volume of medium desired on a countable membrane filter. For control purposes, a similar inoculum was added to lauryl tryptose broth.[12] The initial densities produced by the inocula were determined by averaging five replicate agar plates, then the bacterial suspensions were incubated at 35°C and at the end of one, and again at the end of two hours, five replicate agar plates were planted from the two broths. The data from 20 such investigations are presented in Table 1.

This presentation shows that M-Endo broth during the first hours of contact affects to a great degree the survival and consequently the eventual number of various members of the coliform group. The magnitude

Table 1

Growth Studies of Various Coliform Members

Per Cent of Initial Density

Culture	Lauryl Tryptose		M-Endo Broth	
	After 1 hr	After 2 hr	After 1 hr	After 2 hr
+ + − −	124.5	240.	105.	216.
+ + − −	100.	229.	100.	201.
+ + − −	100.	100.	76.2	72.
+ + − −	107.	201.	102.	196.
+ + − −	104.	197.	55.	100.
+ + − −	115.	225.	107.	206.
− + − −	103.	104.	94.	77.5
− + − −	113.	126.	66.8	72.3
− + − −	95.	92.	68.3	74.0
− + − +	101.5	107.	62.8	82.5
− + − +	106.	106.	77.5	88.8
− + − +	106.	114.	28.2	42.0
− + − +	100.	120.	35.2	73.0
− − + +	98.5	122.	14.1	20.2
− − + +	106.	128.	65.4	87.0
− − + +	116.	149.	68.7	69.7
− − + +	103.	103.	42.6	36.4
− − + +	93.5	91.	64.5	55.0
− − + +	104.	130.	57.3	63.0
− − + +	109.	116.	75.1	80.4

of this effect varies with the species. Thus, the response of different type waters to M-Endo broth in the one-step technique will fluctuate depending upon the numbers and types of coliform species present in the water. This pattern of response has been consistently found in actual practice.

In the early stages of research, it was believed that the most fruitful field for this project to investigate would be in regard to better cultivation of the coliform types able to grow on the M-Endo medium but not able to form sheen. Carbohydrate compounds and bacterial stimulants were added to M-Endo broth without too much success. The carbohydrates were able to assist some weak growers to form sheen, but they also fostered prolific growth of the rapid fermenters with dissolution of the sheen. The carbohydrate compounds were unable to mask the suppressive effect of the fuchsin sulfite environment. Successive reductions in the concentrations of sulfite and fuchsin indicated that the level which was non-toxic to these coliform types was below the concentrations necessary for the production of sheen in a liquid system.

It was gradually realized that in great part the failure of many coliform types to reach full development with the one-step techniques was not that they were prevented from developing a sheen, but that the liquid Endo environment either greatly delayed normal growth or actually killed the organisms.

Diffusion Effect

There are at least two conditions associated with the liquid phase environment of the Endo broth which can be expected to be unfavorable to coliform growth or identification.

1. The liquid phase is favorable to rapid diffusion of any inhibitory by-products of the effects of metabolism on the materials in the medium, with toxic effects on any individuals of the slow growing or susceptible coliform type which were fortunate enough to survive the initial shock of the fuchsin-sulfite environment.

2. The ready diffusibility of food through the liquid phase encourages a practically unlimited growth of the more hardy and rapid fermenters to the stage where the identifying sheen is quickly destroyed by overgrowth and at the same time the weaker types are unable to compete for food.

Sheen Development Time

From the standpoint of laboratory management, the optimum growth with liquid medium which may come in 18 to 20 hours or even less, may arrive at an awkward time, and there is too often a chance that the short-lived peak of sheen formation will have passed before the normal laboratory day begins.

Media Stability

In any bacterial laboratory, apparatus and supplies of media should always be available at a moment's notice. The liquid M-Endo medium, for best results, should be used very shortly after preparation. It is therefore not practicable to store the medium in a condition ready for instant use, for any extended period.

This critical analysis of the disadvantages of the one-step technique, in spite of its convenience, accentuated the need for a new technique. This is true from the standpoint of best coliform recovery and from the point of view of laboratory management.

Proposed Procedure

Enrichment

The inhibiting and/or bactericidal influence shown by M-Endo broth against weak coliforms in the first hours of incubation strongly suggested the need of an enrichment or resuscitation period. Such a period should provide a non-toxic environment for the gradual adjustment of these weaker organisms. Experiments showed the value in providing this bridge for bacterial life between the environment of the samples and that of the M-Endo ingredients. Extensive trials on all sorts of samples, from sewage to the best tap waters, have indicated that two hours, plus or minus half an hour, is sufficient to provide adequate enrichment for the weakest coliforms. This period is not stimulatory for the most rapidly growing varieties. The time appears to be used entirely for acclimation, with a minimum of logarithmic growth. The same trials showed that normal single strength lauryl tryptose broth was a very satisfactory medium.

The two-step method with enrichment thus appears to present obvious advantages in uniform recovery of all types of coliforms. The sole disadvantage, the necessity of changing the filter from the enrichment to the final selective medium, is not so prohibitively time-consuming or laborious as to preclude adoption; it has been minimized by a procedure in which both phases, enrichment and final growth, are carried on in the same petri dish, with only moments required for transfer.

Endo Broth vs Endo Agar

Many of the disadvantages of Endo broth discussed in previous sections were associated not so much with the chemical or growth character of the medium but with its physical characteristics as a substrate. The viscosity of the medium is essentially that of water, so that almost unlimited diffusion is possible. It seemed logical that if viscosity were adjusted the unfavorable effects of the Endo medium on the weaker organisms might well be reduced. The addition of agar-agar to the basic medium was found at once to show these advantages:

1. Enrichment, plus an agar substrate (E & A), almost without exception produced a higher degree of coliform recovery than the Endo broth one-step technique. In some of the samples, additional recovery ran to several hundred per cent. A detailed analysis of the comparative results is presented in a later section of the report.

2. The sheen produced on colonies grown on the agar medium after enrichment was more pronounced than that on the liquid medium and, instead of fading rapidly, the sheen remained, generally without change, for many hours or even for days after its first appearance.

3. This retention of sheen made it possible and advisable to allow a full overall 24 hours of incubation since the danger of losing the characteristic appearance no longer exists. Colonies which develop the characteristic sheen well before 24 hours will retain their appearance, and the slower forms will be given the longer time apparently necessary. It is, therefore, possible to begin analysis of samples almost any time during the working day with assurance that significant results will be available.

Formulation of Endo Agar

At first, the semi-solid medium

was prepared simply by adding agar to the M-Endo broth. Subsequent investigation showed that considerably less fuchsin-sulfate concentration was required with the agar substrate than was needed with the liquid medium to give at least equal sheen; the relative proportions remained unchanged. Eventually, it was demonstrated that the strength of the M-Endo medium could be reduced by 25% and that 1.5% of agar gave best results. The formulation of the medium which has been labeled L. E. S. Endo agar MF is as follows:

Bacto-Yeast Extract	1.2 g
Bacto-Casitone	3.7 g
Bacto-Thiopeptone	3.7 g
Bacto-Tryptose	7.5 g
Bacto-Lactose	9.4 g
Dipotassium Phosphate	3.3 g
Monopotassium Phosphate	1.0 g
Sodium Chloride	3.7 g
Sodium Desoxycholate	0.1 g
Sodium Lauryl Sulphate	0.05 g
Sodium Sulfite	1.6 g
Bacto-Basic Fuchsin	0.8 g
Agar	15.0 g

To re-hydrate the medium, suspend 51 g and 11 ml of ethyl alcohol in 1000 ml distilled water and heat to an incipient boil; agitation is advisable, cool to 45°—50°C and dispense into the smaller half of 60 cm glass petri dishes or disposable plastic dishes. A four ml portion of the agar is sufficient to provide the necessary depth of medium in these two type vessels. To utilize 100 cm petri dishes, 8 to 10 ml of the agar will be necessary. The agar plates should then be stored in the refrigerator and can be used over a two week period. Prolonged exposure to sunlight will cause an intensification of the color.

Procedure in Detail

In the larger half of the petri dish, an absorbent pad is placed and saturated with lauryl tryptose broth. Approximately 1.7 to 1.8 ml of broth will be sufficient. Excess liquid should be removed since it is prone to produce sloppy end results.

The prepared membrane filter is placed on the saturated pad with a rolling motion to prevent air entrapment. The inverted petri dish is then incubated at 35°C for 2 ± ½ hours.

After the enrichment period, the membrane is stripped from the enrichment pad and rolled onto the surface of the Endo agar in the other half of the petri dish. The enrichment incubation allows the agar mass to acquire the temperature of the enrichment phase, thus the temperature gradient at the moment of transfer is practically eliminated. Incorrect placement of the membrane on the agar is at once obvious, since patches of unstained membrane indicate air entrapment between the agar and membrane. The membrane must then be realigned to achieve total contact. Intimate contact is not a necessity for the periphery outside the filtering area. The used pad may be discarded at this time or may be left in the top section for humidity purposes. The petri dish is again inverted and incubated at 35°C. After 22 hours the sheen colonies are counted, preferably using a stereomicroscope having a light source above, and approximately perpendicular to, the plane of the membrane. Other colonies may be counted, frequently providing valuable information.

Discussion of Results

Selectiveness of New E & A Technique

The marked increase in the numbers of sheen colonies developed by this new membrane analysis method obviously made it necessary to inquire into the genuineness of these additional organisms. Our first progress report on this subject[4] indicated that 100% selectiveness might be beyond realization, but that a satisfactory selective test should guarantee a very large proportion of the colonies presenting characteristic growth should be coliforms.

The percentage of verification achieved by this new technique in a great number of studies compared very favorably with the selectiveness of the M-Endo broth. In fact, in many samples the E & A technique showed a higher degree of selectivity. A representative number of these comparative studies is presented in Table 2.

Table 2

Selectiveness Incorporated into Proposed New Technique

Sample Source	M-Endo Broth Technique		E & A Technique	
	Ave. Ct/100 ml	% Verification	Ave. Ct/100 ml	% Verification
Polluted River	25,200	—	43,000	95
Polluted River	30,900	90	45,300	90
Polluted River	21,600	91	42,800	88
Polluted River	27,000	91	32,400	90
River Water	4,700	88	8,100	88
River Water	5,100	93	5,400	92
River Water	3,600	87	5,600	90
Pond Water	142	87	432	77
Pond Water	112	82	136	97
Pond Water	54	93	124	96
Pond Water	50	81	80	84
Pond Water	32	83	48	83
Pond Water	6.4	89	96	85
Pond Water	120	86	470	87
Pond Water	12	88	57	91

The marked increase in the number of sheen colonies by this new method over a wide field of samples was not obtained at the expense of selectiveness.

Inclusiveness Incorporated into Proposed New Technique

The data reported in Table 3 show the comparative types and numbers of coliforms isolated by the liquid medium and the E & A method, in replicate, from Merrimack River samples. It is shown that the recovery of *E. coli* types is not materially changed, but the total number of various types of Aerobacter grown is almost tripled and the numbers of intermediates is almost doubled by the E & A method. The latter members of the coliform group are specifically those which our earlier work has shown were most apt to be lost in the Endo broth membrane filter procedure. This definitely demonstrated the increase in inclusiveness of the E & A technique as compared to the Endo broth technique.

Further confirmation of the beneficient effect of the E & A has been furnished by comparative inoculations of about one hundred pure cultures of Aerobacter and intermediates with enormously improved survival rates and growth ability being associated with the new procedure.

Table 3

Inclusiveness of New E & A Technique

IMViC Code	Verified Colonies No. of Species Recovered by: MF Endo One-Step Technique	E & A Technique
+ + − −	13	13
− + − −	1	3
− − + +	14	29
− + + +	3	4
− − − +	2	14
+ + − +	4	6
− + − +	6	10
+ − + +	1	3
− − + −	1	4
+ + + +	3	5
+ + + −	1	1
+ − − +	0	1
− + + −	0	1
	49	94

Comparison of the Standard Lactose Broth Method and the Proposed E & A Technique

Drinking Water Analysis

The standard multitube technique for determining the coliform density of drinking water has been subjected to a great deal of discussion, and a fair amount of investigation, since the advent of the MF technique. The criticisms most often leveled against the multitube procedure are:

time required for a decision on the quality of the water[13],

small volume which it is possible to test conveniently,

bias reputedly inherent in the method[14],

often excessive amount of unrewarding laboratory work, and

possibility of overgrowth of the indicator coliform organisms by noncoliforms in the lactose environment.

Proponents of the membrane filter technique stress the comparative advantages for the corresponding points:

analysis can be completed within 24 hours, without verification,

more water can be conveniently examined from a given sample,

MF is a plate count method and, therefore, inherently free of bias in theory; in practice its bias be none or very small,

laboratory manipulations are minimized since fewer false positives are found, and organism is fixed on a plane surface allowing distinct growth of individual colonies, with a minimum possibility of interference.

Comparison of Standard Procedure and Membrane Filter

Of the routine drinking water samples received at the Lawrence Experiment Station during a two month period, 654 were examined in parallel by the standard lactose broth multitube procedure and by the new E & A technique. The samples came from Massachusetts municipal supplies, from Army and Navy facilities and from State recreational areas. The results are shown in Table 4.

For each sample, a volume of 100 ml was taken for examination by MF and the usual five portions of 10 ml each were inoculated into standard broth tubes.

Data indicate that 87% of all the samples were found free of coliform by the MF technique; all of these could be reported as negative one day after the receipt of the sample. By the fermentation tube technique, because of the requirement for 48 hours incubation, only 59.5% of the samples could be reported as negative after *two days*. After another

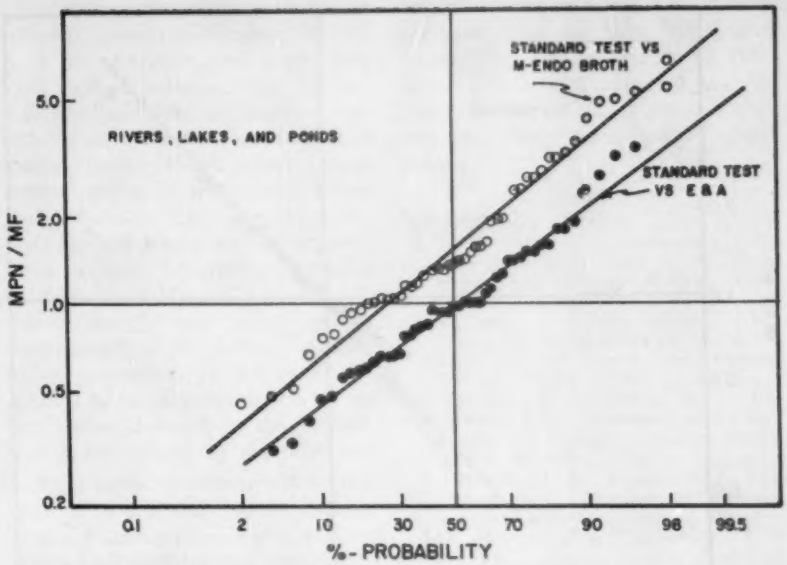

Fig. 1. COMPARISON OF standard multitube test against M-Endo broth membrane filter and against E & A membrane filter.

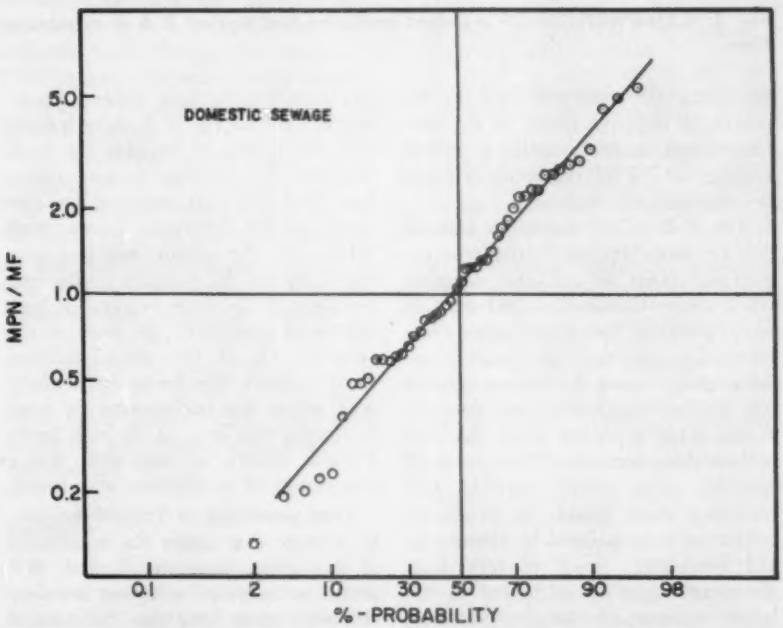

Fig. 2. COMPARISON OF standard multitube test against E & A membrane filter.

Table 4

Comparison of Standard Procedure and E & A Membrane Filter

	E & A Membrane Filter			Standard Fermentation Tube		
Total Number	Samples with no sheen colonies	Samples with one or more sheen colonies	False Positives	Samples with no Positive Presumptives	Samples with no Confirmed Positives	Samples with Completed Positives
654	567	87	3	389	220	45

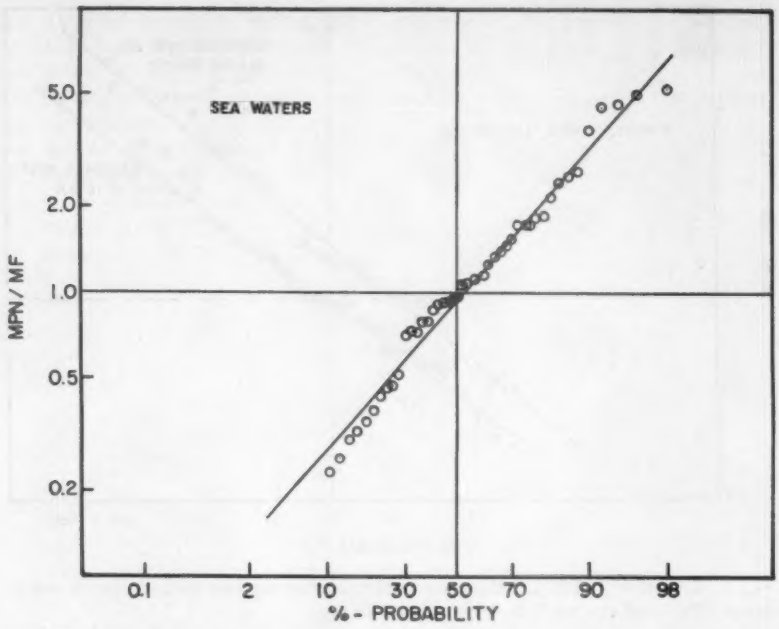

Fig. 3. COMPARISON OF standard multitube test against E & A membrane filter.

48 hours, the time required for reporting a negative result in the confirmed test on presumptive positives, another 33.7% of the samples could be reported as negative.

The E & A MF technique showed one or more verified[15] coliform organisms from 84 of the samples, while only 45 samples had one or more positive completed tubes from broth. In four samples, positive results were found by the completed test on one tube each, and no coliforms were reported from the MF test on these samples. There were 43 samples, from which verified MF coliforms were found, in which no coliforms were isolated by the standard procedure. Some of this disagreement might be attributed to the larger volume of sample examined by the MF test.

On the 87 samples from which positive MF tests were found, only three were shown in which all the sheen colonies failed to verify. By comparison, of the 3270 total tubes inoculated from the samples, 522 positive lactose tubes failed to confirm. In other words, about 16% of all the tubes inoculated were processed through the confirmation test without any positive coliform results. This is a rather important picture of the excess work which the standard method may involve.

The verification of each sheen colony found in drinking water is an essential part of the E & A technique. For this group of samples the work involved in verification was rather less than half that required for carrying out the confirmed test on broth tubes. Of the sheen colonies produced by the 87 samples giving any positives, 87% were verified, a high degree of selectivity. In most of the samples, all of the sheen colonies were verified, this being particularly true when the background of non-coliforms was low. With high background counts, a somewhat lower proportion of verification was found.

Data assembled in Table 4 definitely indicate that under the conditions of this comparison, the E & A MF technique operated a higher recovery efficiency than did the Standard Lactose Broth test. Even if the effect of the larger volume is discounted, it appears that the E & A technique finds larger numbers of coliforms than the Standard Procedure in waters of drinking quality. Many observers have, from time to time, reported that the Standard Procedure recovers only a part of all the coliforms present. For example, much larger coliform recovery has been reported from the droplet method.

It appears that this E & A test, which includes only slight alterations in medium and technique, may produce greater coliform recovery in many samples than the standard multitube procedure, rather than the smaller recovery generally reported with earlier techniques. The significance of the higher numbers still must be determined.

Additional Information from the Membrane Filter

Although the greatest usefulness of the membrane filter technique in water bacteriology at present is the enumeration of the coliform population, much added information in regard to other bacterial flora is available. Very seldom does an incubated filter show any coliform. Non-coliform organisms may be very significant. In swimming pool samples, for instance, the total count will furnish valuable information as to the sanitation of the pool, even if coliforms are few or absent. Certainly in the examination of a drinking water, it would be highly significant to find several hundred organisms resulting from the filtration of only perhaps 100 ml of tap water. Already it has been shown that the presence of considerable numbers of non-coliforms may foretell the later presence of the indicator organisms. The fermentation tube gives practically no such information, since gas production is the only important indication observed, and the turbidity which may appear after 24 or 48 hours of incubation gives little information of the original bacterial density of the sample, nor does it call the attention of the bacteriologist to possible approaching difficulties. The membrane filter, on the other hand, gives an estimate of the coliforms present, and as a bonus, also gives an estimate of other bacteria growing under the conditions presented.

This function of the membrane filter has not received much comment, but we believe it may prove meaningful in the bacteriological analysis of drinking waters. As stated above, high non-coliform counts may presage later appearance of the indicators. And it appears logical, even if coliforms are not shown, that a significant number of non-coliforms may indicate a "dirty" water, undesirable from the esthetic standpoint, at least, and demanding that steps be taken to produce a water free of non-coliforms as well as coliforms.

Polluted Waters

The results obtained by the E & A membrane filter method on waters not of drinking water quality are reported in graphical form in Figures 1, 2, and 3.

Figure 1 represents the analyses of 49 river, pond and lake samples that were examined by the E & A, one step M-Endo broth and the 5-5-5 multitube techniques. The ratios of the MPN to E & A and the MPN to M-Endo broth (one-step) results were calculated and arrayed in order of magnitude. The two sets of data were then plotted on log probability paper. The two lines of best fit show the difference in response produced by the two membrane filter methods.

Of the 49 ratios $(\frac{\text{MPN}}{\text{MF}})$ calculated from the one-step membrane filter method, 39 equal to, or greater than unity, while the MPN/E & A array showed that 23 ratios were equal to, or greater than unity. This comparison shows that the one-step membrane filter method using M-Endo broth as usual tends to give lower results than the MPN procedure. The E & A membrane filter analysis of waters of these types gives results practically equal to those from the tube method. The median ratio, or 50 percentile ratio, for the MPN/one step MF is 1.53 while the MPN/E & A MF is 0.97.

Figure 2 represents the analyses of 49 raw, settled and biologically treated sewage samples by the 5-5-5 multitube method and by the E & A membrane filter method. The ratios of MPN to E & A coliform densities were calculated, arrayed and plotted on log probability paper. The median or 50 percentile ratio of the 49 ratios is 1.10, with 26 ratios equal to, or greater than unity.

An independent comparison of the coliform recovery efficiency of the E & A technique and a one-step agar method indicated that the enrichment phase did not increase materially the coliforms recovered from sewages and polluted rivers. These results confirmed well-known beliefs that the nearer the source of pollution, the less attenuated are the coliform strains. Therefore, smaller numbers of coliforms fail to withstand the inhibitory effects of the environment of the various bacteriological procedures. In this study, this appears to be particularly true of the inhibitions observed in the fuchsin-sulfite atmosphere of the MF test.

It probably, therefore, will be possible to recommend that on examinations of sewages and highly polluted rivers and streams the enrichment stage of the E & A membrane technique may be omitted without significant effect on the coliform recoveries. It is very probable that considerable reduction in the non-coliform background will also be found.

Figure 3 presents the array of 49 3-3-3 multitube and E & A membrane filter ratios calculated from simultaneous analyses on sea waters. The filters were washed with sterile buffered water in the same manner as that used in drinking waters. It was not found necessary to use three to five additional washes as had been earlier indicated. The 50 percentile of the array is 0.96, and 24 of the MPN/MF ratios were equal to, or greater than unity, thus indicating a very close agreement with the tube MPN.

Summary

In our paper on the reliability of coliform tests[3], we stated the membrane filter appeared to possess the best possibility of a test with greater precision than the tube MPN and enumeration of all strains of coliform. The results reported in this paper indicate that a considerable step has been taken toward these goals.

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Chemung River Drainage Basin Survey Series Report No. 2

The Water Pollution Control Board of the New York State Department of Health has recently released a report on the Chemung River Drainage Basin Survey Series. The Report is No. 2 in the series.

The general result of the survey was that the main rivers, Tioga, Canisteo, Cohocton and Chemung proper, are not grossly polluted, with the notable exceptions of a 10 mile stretch of the Canisteo River below Hornell and a short segment of the Cohocton River below the Village of Cohocton.

Lakes and ponds in the basin were determined to be comparatively free of pollution.

Pollution in the basin, while generally not critical, is restrictive, according to the report, and affects primarily the food supply for fish.

Numerous milk plants present problems of potential pollution, but the most serious problems in the basin involve municipal sewage that may also contain industrial wastes and a tannery in Pennsylvania located on a tributary of the Tioga which can affect New York State waters.

Silting from the runoff of agricultural lands is also a factor in the reduction of food potential in the stream, the report states.

Instrumentation in Water Pollution Control

by ROBERT H. JONES
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■ QUALITY WATER in tremendous quantity at reasonable cost has long been the goal of those responsible for the public water supply. This goal has been met. Continuous analytical instrumentation has contributed in some measure to this attainment. The first role of analytical instrumentation in the water industry has been in treating processes. Examples are in the use of pH, colorimetry, and chlorine analysis instrumentation.

More recently, the problems of stream pollution have become more and more manifest. Industrial use of huge amounts of water, along with the need to return this water, frequently contaminated with industrial wastes, to our rivers and streams have created new challenges for water management. Water supplies must be protected for the downstream users. Protection of aquatic life and the maintenance of natural waters for recreational purposes are corollary problems. In meeting these problems, water management has made use of some of the older types of instrumentation in new applications. Some examples are pH, conductivity, and oxidation-reduction potential. Yet, new instruments must be developed, and older instrumentation improved to help water management meet the challenge of stream pollution control.

What Is a Pollutant?

The logical question arises, "what is a pollutant?" A possible answer is: "A pollutant is a substance not found in natural waters which renders the water unsatisfactory for use for industrial purposes, or for the propagation of aquatic life, or for use for recreational purposes, or for use for human consumption without the need for extensive or expensive treatment."

With thousands of industrial establishments discharging thousands of different substances into the nation's streams and rivers, it soon becomes apparent that there can be thousands of different stream pollutants. A second question, then, is in order. "What specific contaminants do we want to measure?" Certainly, this is a difficult question to answer, and yet an answer is required if new instrumentation is to be developed.

There is presently available certain continuous stream analyzers which are useful in certain areas of stream pollution control. Here, it might be well to define "continuous analyzer." Briefly, a continuous analyzer is an instrument which quantitatively measures a constituent in a process stream instantaneously or repeatedly without requiring assistance from operating personnel. Since, obviously, no instrument should or could be expected to function indefinitely without human assistance, this definition should be modified to imply a reasonable or practical operating time without human assistance.

Monitoring Stream Pollution

With the tentative definitions of a pollutant, and of a continuous instrument, can it be said that there is instrumentation available to meet the needs of water management in continuously monitoring stream pollution? A few examples indicate this to be, at least in part, the case. pH analyzers have long been available for the continuous measurement of acidic or basic contaminants. Conductivity instruments are of value in the determination of total dissolved solids. Oxidation-reduction potential instruments, while possibly of limited value, are available for use where applicable. Specific ion measurement instruments, such as the chloride ion analyzer, have been used by ORSANCO and others to monitor chloride content of rivers. Continuous dissolved oxygen analysis by polarographic and other methods is presently being used.

While it is not intended that the above examples be a complete listing of available instruments, it is interesting to note that those mentioned use, for the most part, relatively simple electrochemical techniques. In fact, if we consider only the polarographic method for dissolved oxygen analysis, then it can be noted that all five of the examples entail the use of some form of electrode measurement. We can speculate on whether there is any reason for this.

Major Problems in Analyzing Pollution

What are the major problems in continuous water analysis in the stream pollution field? Is there something unique here that separates this area from the common industrial applications?

Basically, the water technologist cannot place his instrument in a relatively cozy environment as can, for example, the chemical plant or refinery operator. Nor can he maintain a crew of highly skilled instrument mechanics ever available to correct any malfunction due either to the instrument itself or to some condition of the stream. Finally, he may not have a clearly defined sample, as in a contained piped stream, but he must make his measurement in a large, and not necessarily homogeneous, river or stream. Under these adverse conditions, his basic requirement remains—instrumentation which will function reliably and accurately for long periods of time without human intervention. This recalls the definition of a continuous analyzer.

Thus, there are these three major problem areas. Restating, they are: the measurement point; the reliability of the sensing element; and the difficulty in providing routine or adequate maintenance.

The problem of the measurment point is in reality twofold. First, there is frequently the need to locate the entire instrumentation at a point remote from those concerned

with the information gathered. This, of course, means that the instrumentation is required to function without attention for long periods of time. Secondly, there is the problem of locating the sensing element. Either the sensing element is taken to and located in the stream, or a portion of the stream is brought to the sensing element. Neither method is completely satisfactory because of the possibility of non-representative sampling. This might be due to stratification or poor mixing. An example is in sea water intrusion where different concentrations of salt might be observed at various depths. Or, in the case of dissolved oxygen, the point of interest to a limnologist may be in a so-called micro-habitat where anything but *in situ* measurement would be meaningless.

Generally speaking, we can conclude that location of the sensing element in the stream is the more desirable from the sampling standpoint. However, such location, because of inaccessability or the need for long electrode leads or amplifier location, only complicates the already difficult maintenance problem.

Any analytical instrument can be considered to consist of two basic components. These are the sensing element, or system where chemical or physical changes take place to provide a significantly measurable variable; and the amplifier which amplifies the detected signal to provide meaningful readout. The amplifier should be considered first. It is the least troublesome. Advances in electronic design, and the use of solid state devices, have made possible the development of amplifiers capable of long-term, stable, drift-free operation with minimum maintenance. Shielding and built-in voltage stabilization minimize difficulties from electrical interference. Moreover, the amplifier can be packaged in a sealed or gasketed housing which protects it from an unfavorable environment.

This is not so with the sensing element. It must go directly into the stream. There it is subjected to all the hazards of an unfavorable environment. For example, the glass electrode is the only practical means for continuous pH measurement. Yet, this relatively thin, fragile bulb of glass must withstand chemical attack and erosion from the stream. It must withstand abrasion and impact from suspended solids. It must withstand shock from temperature and pressure changes. And, all the time, it must produce a signal of the micro-microampere level while measuring a substance which might exist in the parts per billion level or less. It is asked to do this day after day without attention, and without losing its accuracy or calibration. The sensing element of the analytical instrument is subjected to all the hazards of the stream. Coating by silt or solids is only one of these hazards, and should this happen to a degree that it becomes isolated from the stream, it cries out for human assistance.

All of which, says instrument maintenance, is a must in water analysis even if complicated by the remoteness of the measuring point and the reliability of the sensing element. Under the best of conditions, instruments will require routine calibration, standardization, or adjustment. Under conditions found in water pollution analysis, routine maintenance may be required, if only to keep the sensing element free from extraneous coating.

Generally, frequency of maintenance will depend on two factors—the instrument itself and the conditions of the stream. Obviously, the simpler the instrument the less the need for maintenance. Equally obvious, the more vile the stream in terms of those things which attack, or in some way effect the sensing element, the more frequent must be the inspection and care of the analyzer.

Future of Continuous Instrumentation

What, then, is the future of continuous analytical instrumentation in water analysis? The answer is that the pressing need for stream pollution control will demand that new instruments be developed to measure contaminants which may yet be unnamed. So, we must turn back to the question, "what is a pollutant?" What are the needs of water management? What do you want to measure? With the answers to these questions, the instrument industry will be in a better position to develop new instruments to meet water management's needs. Still, it must be realized that vast sums of money cannot be spent to develop instruments for a very limited usage. Where the need for special instrumentation arises, cooperative effort is required on the part of maker and user alike.

In the realm of both old and new instrumentation, a greater understanding is needed for the problems of both the instrument user and the instrument maker. The user wants an analyzer which once installed can be plugged in and essentially forgotten. The instrument maker would like to provide just such an analyzer. Unfortunately, neither is likely to realize this goal. While the instrument maker is continually striving to produce more reliable and trouble-free analyzers, the instrument user must recognize that in the present state of the art, at least some human assistance is required to maintain instrument accuracy and working order. Common recognition of these mutual problems will lead to better utilization of instrumentation, and the development of new instrumentation which will serve the common good.

Rudolfs Research Conference Proceedings Available

Proceedings of the Rudolfs Research Conference held at Rutgers University in June, 1960 on the Principles of Colloidal Behavior and their Application to Water Sanitation has been made available by the University.

The concept of the Conference was based on the recognition of the need for a greater understanding of the basic sciences upon which the applications and solutions of problems in waste and wastewater technology depend.

The Principles of Colloidal Behavior and Their Applications to Water Sanitation was selected as the specific theme of this Conference because of the specialized nature of Colloid Chemistry and the importance of colloid phenomena in water, wastewater and sludge treatment.

The report containing the proceedings may be obtained for $2.00 made payable to Rutgers University and mailed to Miss. B. Crenner, Secretary, Department of Sanitation, Rutgers University, New Brunswick, N. J.

Waste waters now discharge 3,850 ft into Santa Cruz Bay (Calif.) after . . .

Placing a Submerged Ocean Outfall

by F. D. LYON,
Watsonville, Calif.

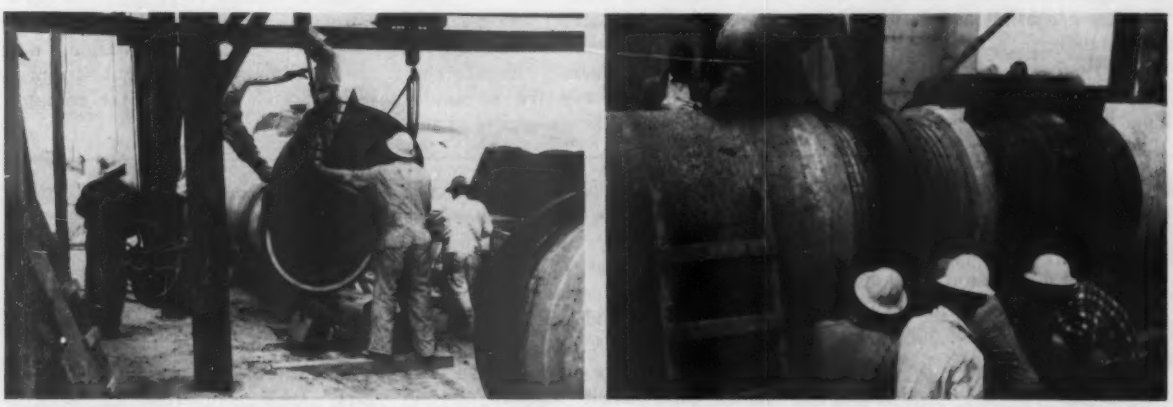
EDITOR'S NOTE: This article reports briefly on how a 3,850 ft sewer outfall was laid on the floor of Santa Cruz Bay. The steel pipe was was joined, coated and inspected on shore, then pulled out to sea by winches. Usually an expensive and difficult operation, the actual pulling of the nearly three-quarters of a mile of pipe took 32 hours. The cost of the outfall installation was about $460,000.

■ THE FREEDOM SANITATION DISTRICT of Santa Cruz County, Calif. has just completed a new ocean outfall sewer extending 3,850 ft into Santa Cruz Bay. This was the first fixed declivity and heaviest outfall pipe pulling project of record on the Pacific Coast. The submerged outfall will receive primary effluent from a new sewage treatment plant on the outskirts of Watsonville and the industrial wastes from the area. The industrial effluent pipe line of 22 in. diameter and the 42 in. sanitary effluent pipe line run parallel three miles to a beach surge chamber, where they combine to enter the new ocean outfall line.

The ½ in. wall thickness, 39 in. diameter steel pipe was hauled to the beach in 30 ft. lengths. The outfall piping was welded into 480 ft lengths on the beach and each weld was inspected using x-ray techniques. These lengths were laid parallel to the pulling line and each was equipped with end bolting flanges. On the pipe interior, a 1 in. coating of spun mortar was applied to 4 x 4 wire mesh. This cured for 7 days. On the pipe exterior ¼ in. steel wire was wound at 1 in. intervals, covered by a 3 x 4 wire mesh, then a ½ in. coating of fiber glass and coal tar applied. Over this, a 3 in. Gunite mortar coat completed the exterior protection, giving a total pipe diameter of 42 inches.

Tractors pulled the 480 ft lengths to the pulling line on triple rubber-tired rollers set in cradles which were spaced at 24 ft intervals. These cradles were designed to support 50 degrees of the pipe's lowest periphery. Hydraulic jacks were used to place the pipe on the cradles and to obtain proper roller seating. On the 1 per cent slope, a tractor hold-back winch released the pipe lengths which traveled on the rollers and permitted end flange bolting of fabricated lengths. The bolted flanges received a coal tar application before placing a sheet steel recessed clamp, which was grouted to refusal. The action of the sea water is expected to disintegrate the steel clamp, leaving the tar and grout to satisfactorily seal the bolted flanges.

At the sea end of the joined pipe, a sealed pulling head was attached by cables leading over a pulling buoy to a barge 200 yards offshore. The barge was equipped with diesel motor winches. Because of the heavy fog, it was impossible to see the pull-



GROUTING SLEEVE being fitted on the first section (left) prior to flange bolting (right). The sleeve will then be placed to cover the joint and cement grouted.

ing barge or the hold-back winch from the central pull controlling point, so a radio-phone was utilized. The pulling head end of the pipe was mounted and the pipe was centered between driven piles on the beach. The final 100 yards to water was over sandbags. The barge winches made 2 ft closely inspected pulls as roller assemblies were moved in to insure level at low spots and bulldozers cleared out intruding sand. Though it had been estimated at 48 hours, with the thorough preparation and co-ordination, the pull was actually completed in 32 hours.

During the entire pulling operation, divers continually inspected the pipe for rotation, and after the pipe was attached to the surge chamber, they removed the end pulling head and opened the end air valve, dropping the pipe down 60 feet to the ocean floor. Though the pipe weight was 856 pounds per foot on shore, in the water with the buoying entrained air it weighed only 10 pounds per foot.

To supplement the end outfall capacity of the pipe, there are twelve staggered 8 in. diffusers which can be opened if required. With the installation of this new outfall sewer, the two former 16 in., 1750 ft outfalls will be abandoned.

The new primary sewage treatment plant provides for both pre and post-chlorination. The sewage flow, half sanitary and half industrial wastes, will require the outfall to handle a combined flow of 6.7 mgd. In treating the sanitary wastes, a BOD of 6,000 pounds daily will drop to 4,500 pounds daily, a decrease of 25%, with the suspended solids dropping from 6,000 pounds daily to 2,700 pounds daily, a decrease of 55%; in the industrial, BOD will decrease 15% from 2,400 pounds daily to 2,040 pounds daily; the primary consideration, the industrial suspended solids, dropping 60% from 2,400 pounds daily to 840 pounds daily.

The new sewage treatment plant is a joint project of the City of Watsonville and the Freedom Sanitation District of Santa Cruz County. It is financed by revenue bonds, and will probably be assisted by increased sewer service charges. The new outfall was a separate obligation of the District.

FIRST LENGTH of outfall in place between aligning piles. The pulling head is attached ready for the pull.

FIRST SECTION of the outfall shows diffusers. The pulling buoy is shown at the top right with pulling lines extending out to the winching barge located a quarter of a mile out in the fog.

Site Conferences

Continued from page 236

the papers stacked all in one pile, I saw that I ought to have a site conference any time the unanswered pieces of paper numbered more than a couple of score. We could then take them one by one. discuss them, and draw lots as to who should supply the necessary answer.

I can't do it today because everyone is so frightfully busy. In fact, there isn't anyone around at all. I wonder where everyone disappears to for so long without saying where they are going? Perhaps I should hold a site conference about that?

Proceedings Available

Rutgers University has announced the availability of Proceedings of the Rudolfs Research Conference held in 1960 on the subject, "Principles of Colloidal Behavior and Their Application to Water Sanitation." Five papers are presented in full in this illustrated 143-page book. It can be obtained for $2 from the Department of Sanitation, Rutgers University, New Brunswick, N. J.

RESEARCH PROGRESS REPORT

Culture and Harvest of Attached Algae
grown on domestic sewage

Part 1

by GEORGE W. REID, Prof. of Sanitary Engr. and JOSEPH R. ASSENZO, Asst. Prof. of Sanitary Engr., University of Oklahoma, Norman, Oklahoma

EDITOR'S NOTE: This Research Progress Report will be presented in two parts. Discussed here are some considerations involved in the use of attached algae to improve wastewater plant effluents and their possibilities as a food source. Part 2, to be presented next month, will describe laboratory studies and pilot plant operations. This work has been performed under U.S. Public Health Service Research Grant RG-5422.

■ IN MANY RIVERS, especially the intermittent rivers of the Southwest, algal cultures grow on the effluents from sewage treatment plants, and in time of low flow they die, decay, and produce taste and odor problems. By using the nutrients contained in the sewage to grow a controlled algae culture, this stream pollution problem may be eliminated. Conventional sewage treatment does not utilize the nitrogen and phosphorus of the sewage; this is a waste of useful elements which is unnecessary. These are nutrients which the algae can utilize and, in turn, the harvested algae may be used for feed and/or fertilizer.

It has been estimated that domestic sewage could produce from 1,200 to 1,400 pounds of protein per day from a population of 10,000 persons. Algae grows well in domestic sewage which has adequate nutrients and which flows on a sustained basis. Although domestic sewage does carry some industrial wastes, the wastes are not usually sufficiently toxic to prevent algal growths. Consequently, if the studies with algae prove successful, the results will be improved effluents and a new food source.

In the near future, expanding growths of cities will cause the increased discharges of sewage effluents in the proximity of surface water intakes. As such, particularly in the Southwest where the only stream flow in dry weather may be treated sewage, bacterial, nitrogen and phosphorus removals greater than are ordinarily encountered in conventional sewage treatment will be mandatory. There is evidence that algae under controlled conditions will accomplish this.

In the business of water resource development as greater BOD removals are experienced, nutrified effluents become pollutants. The extent of current knowledge dictates dilution, with 90 per cent or greater BOD removal, of 3 to 4 volumes of stream flow per volume of sewage effluent to prevent algae trouble. This implies the need for 4 volumes of stream flow to develop 1 volume of usable municipal water. Low flow augmentation and not water demands may become the limiting growth factor in the Southwest.

The advantages of using algae as a source of oxygen in conjunction with the aerobic bacterial decomposition of sewage has been pointed out by many investigators. Since oxygen is only slightly soluble in water, using atmospheric oxygen is a very slow and expensive process. The carbon dioxide, ammonia, phosphates and many trace elements released by the bacteria are necessary for the growth of algae. There is established a type of symbiosis when algae and bacteria are cultured together in sewage.

The organic matter produced by the algae themselves is greater than the organic matter in the sewage. Therefore, it is necessary to harvest the algae at regular intervals. Because algae grown in sewage have a high protein content and can be used as a source of food, the economics of the process has some attraction which have stimulated researchers beyond the health aspects of the situation. Through a long series of investigations, Gotaas[1, 2, 3, 4, 5, 6, 7, 8, 9] and his co-workers have quantified the process involved and worked out many of the engineering problems encountered in such a program. Their work has been done primarily with unicellular, or free-floating, forms of algae. One of the major difficulties has been finding a practical and economical method of harvesting the unicellular forms of algae. Because of the gelatinous nature of the cell walls of these organisms, ordinary filtering processes are far too slow and ineffective. Although several methods have been tried [5, 9], none up to now have proven entirely satisfactory.

Actually, harvesting is the only real disadvantage of the free-floating process. The algae are easily grown, they can be grown in large numbers in tanks or basins, and they can be fed chemicals and carbon dioxide. Processwise, aside from harvesting, a sewage treatment process prototype such as activated sludge would certainly be feasible, wherein organic material is oxidized by free-floating slime, settled and the slime returned.

One obvious approach to harvesting would be to use attached forms. If algae can be grown naturally on surfaces, scanning and scraping are quite easily accomplished. Sewage is also treated by slimes grown on surfaces in such devices as the contact-aerator and the trickling filter. Why could not this serve as a prototype for a plant to grow and harvest attached algae? It was envisioned that the principal practical problem would be concerned with the ability to provide enough usable surface area, all exposed to sunlight. In sewage treatment sunlight is not necessary; so to be feasible attached algae must take up the nutrients, not just as rapidly, but more rapidly than bacterial slimes. To point up, for comparative purposes, it must be ascertained whether the ease of harvesting attached algae will offset space requirements for growth.

Many other questions present themselves; for example, the adaptability of algae to temperature and sunlight changes, effects of toxic material, actual amount of nitrogen and phosphorus remaining in the effluents, types of algae and bacteria, and the interrelationship of bacterial and algal growths. All of these data, of course, must be for attached cultures.

Search For Suitable Algae

Studies were conducted at the University of Oklahoma to investigate the feasibility of developing an attached algae on sewage effluent. It was hoped the algae would reduce the nutrient content of the sewage sufficiently to prevent stream pollution, especially in dry weather flow receiving streams. The study was divided into three phases: A, investigations to determine suitability of attached algae for cultivation in sewage; B, trial cultivation and harvesting of algae on bench-scale, or laboratory scale, apparatus; and C, development of pilot-scale algae cultivation apparatus.

The first phases of the current study were concerned, of course, with the reported work of others and with field investigations for algae suitable for laboratory culture.

If one considers the entire number of species of algae, the range of conditions under which they will grow is quite wide. The largest number of algae grow in a water habitat. Some of these are found in flowing streams, some in lakes and ponds, some in pools and ditches, and other in bogs and swamps. Those found in flowing streams vary according to the speed of the water. For example, those on a waterfall are quite different from those found in the slower flowing parts of a stream. Those found in lakes and ponds may be subdivided into two groups: A, the attached forms, and B, the free-floating or plankton forms. The species found in bogs and swamps vary from those that form gelatinous masses on submerged plants and other objects to those that grow at the interface between the water and the atmosphere.

The temperature range under which algae will grow, depending on the species, is extremely great. Certain species reach the optimum growth rate only in conditions of full sunlight, while others will grow only under shady conditions. While there is a geometric decrease in intensity of illumination with an arithmetic increase in the depth of water, many species show a greater rate of photosynthesis at a certain depth than they do at the surface. There is, of course, a qualitative penetration of light in water. The greatest amount of absorption is at the red end of the spectrum, while the violet end penetrates the greatest distance. This results in a vertical distribution of attached species in deep bodies of water.

The elements essential for the growth of algae are the same as for higher plants with minor variations. Calcium is not essential for some species of algae. Some elements are toxic to the algae. Iron is the most common one in nature. If the iron (Fe_2O_3) content of water gets above 5 mg per liter, there is a distinct toxic effect. Although algae are frequently found in waters containing more iron than this, the toxic effect has been neutralized by the buffer effect of organic compounds of calcium salts. Most algae grow well when the source of nitrogen is either nitrites, nitrates or ammonium compounds.

Geigel[10] found *Chlorella* can withstand up to 30 ppm of Boron before growth was decreased. He also found they could survive in solutions containing up to 140 ppm.

For any particular species, the limitations are fairly narrow. Although the conditions may change greatly, there always seems to be some species of algae which survive the environment of a sewage disposal plant. If the conditions under which the algae are growing are not changed abruptly, the flora will change to the new environment.

With such a great genetic variation as far as toleration for the environment is concerned, it is not surprising to find that many species will grow under the conditions that prevail where sewage is discharged.

Information on attached algae and attached algae in sewage was not to be found. More than a hundred references were covered, forty of which were felt to be of sufficient general information to be included in a bibliography. Ample information was available on the nutrient requirements of free-floating species, sewage tolerant species, the limits of light intensity, frequency, use of interruptions, as well as conversion efficiency[4, 11, 12, 13, 14, 15, 16]. There was data on environmental factors associated with sewage such as temperature, pH, and boron tolerance, as well as the nitrogen and phosphorus levels in sewage[1, 2, 3, 10, 17]. Algae culture techniques using free-floating species were also well covered[5, 7, 9, 18, 19, 20, 21, 22].

The only real reference to attached algae grown in sewage was one by Letts in 1913 concerning *Prasiola crispa*[23]. According to Letts, it grew well in a sewage environment using tremendous quantities of nitrogen. A six-month search for this species resulted in finding some in Alaska. These algae were not adaptable to our environmental criteria. Gloyna in his studies did indicate the presence of attached forms in lagoons and that these appeared to thrive at higher organic levels than did the free-floating[24].

The only approach available as a result of this review was to take to the field and locate algae in sewage environments and then bring them to the laboratory for cultivation. Field trips were conducted on the rivers and streams in Oklahoma and particularly in sewage outfalls. Numerous samples were brought to the laboratory. Sewage plants were also studied and yielded samples.

The most profitable source of information on free-floating algae and sewage use was the sewage lagoon or stabilization pond. Oklahoma has

many of these operating under a variety of conditions; some receiving raw sewage, some secondary effluents, and some used as polishers. Ten ponds were selected for study and to obtain sewage tolerant species, and also to learn about nitrogen, phosphorus and bacterial removals.

Two surveys of several stabilization ponds in the Oklahoma area were conducted. One survey was conducted during the latter part of May, 1959, and the second was conducted during the middle of January, 1960. One purpose of the surveys was to determine the density of and species of algae found during both seasons, summer and winter. Another purpose was to determine the efficiency of these stabilization ponds in removing nutrients.

It was found that the most dense algal population was in stabilization ponds whose influents were previously treated. Raw sewage ponds were sparsely populated, relatively speaking. As might be suspected, the greatest removal of nutrients was by ponds with the greater algal densities.

Reference will be published at the end of Part 2.

Construction (including water and sewage works) figures for 1960

For the calendar year 1960, the value of new construction put-in-place totaled $55.0 billion. This was just 2 per cent below the record total of $56.2 billion reported for 1959. Expenditures for private construction at $39.0 billion were also 2 per cent below 1959, while public construction at $16.1 billion was only 1 per cent less than the $16.3 billion reported in 1959. →

John B. Harrington Dies

John B. Harrington, former Director of the Division of Sanitary Engineering of the West Virginia Department of Health died March 6, at the Veterans Hospital in Beckley; he was 62 years old.

Mr. Harrington served with the West Virginia Health Department from 1925 until 1949 when ill health made it necessary that he retire. He was well known for his work in the field of public water supply and was particularly successful in improving the standards of filter plant operation in the State.

Lower Hudson River Drainage Basin Survey Series Report No. 8

A report covering approximately 100 tributaries that drain to the Hudson River has been released recently by the Water Pollution Control Board of the New York State Department of Health.

The report is the eighth in a series of surveys.

The results of a stream sampling program and data obtained from other sources were utilized in order to describe water quality and to determine the effect of pollution sources on water quality.

Table 1.—Value of New Construction Put in Place in the United States

(Includes Alaska and Hawaii)

Type of Construction	Value (in millions of dollars)						Per cent change		
	1960				Annual Totals		Dec. 1960 from—		
	Dec.	Nov.*	Oct.*	Dec.* 1959	1960	1959*	Nov. 1960	Dec. 1959	1960 from 1959
Total new construction	4363	4774	5063	4410	55017	56206	— 9	— 1	— 2
Private construction	3149	3398	3484	3247	38956	39949	— 7	— 3	— 2
Residential buildings (nonfarm)	1739	1885	1949	1901	22067	24469	— 8	— 9	—10
Non-residential buildings	872	923	912	805	10008	8859	— 6	+ 8	+13
Industrial	265	263	256	216	2861	2106	+ 1	+23	+36
Commercial	357	382	372	340	4064	3930	— 7	+ 5	+ 3
Other nonresidential buildings	250	278	284	249	3083	2823	—10	[1]	+ 9
Farm construction	89	100	106	104	1286	1362	—11	—14	— 6
Public utilities	426	463	490	415	5312	5052	— 8	+ 3	+ 5
All other private	23	27	27	22	283	207	—15	+ 5	+37
Public construction	1214	1376	1579	1163	16061	16257	—12	+ 4	— 1
Residential buildings	58	59	60	60	715	962	— 2	— 3	—26
Non-residential buildings	386	404	443	326	4743	4514	— 4	+18	+ 5
Military facilities	113	125	135	110	1324	1488	—10	+ 3	—11
Highways	402	487	604	418	5685	5916	—17	— 4	— 4
Sewer and water systems	**113**	**119**	**128**	**115**	**1488**	**1467**	**— 5**	**— 2**	**+ 1**
Public service enterprises	43	55	66	37	651	551	—22	+16	+18
Conservation and development	79	106	121	84	1230	1130	—25	— 6	+ 9
All other public	20	21	22	13	225	229	— 5	+54	— 2

[1] Change of less than half of one per cent.

* Revised

Table 2.—Value of New Construction Put in Place in the United States, Seasonally Adjusted Annual Rate in Current Dollars and in 1947-49 Dollars

(Includes Alaska and Hawaii)

Type of construction	Seasonally adjusted annual rate (millions of dollars)					
	Current dollars 1960		1947-49 dollars 1960		1959	Per cent change, December 1960 from December 1959 in 1947-49 dollars
	Dec.	Nov.*	Dec.	Nov.*	Dec.*	
Total new construction	54835	55011	38069	38192	38935	— 2
Private construction	38884	38665	26602	26427	27727	— 4
Residential buildings (nonfarm)	21978	21496	15789	15431	17220	— 8
Non-residential buildings	10121	10335	6697	6839	6252	+ 7
Industrial	2982	3036	2057	2094	1680	+22
Commercial	4214	4198	2754	2745	2676	+ 3
Other nonresidential buildings	2925	3101	1886	2000	1896	— 1
Farm construction	1184	1241	870	914	1039	—16
Public utilities	5320	5282	3086	3065	3048	+ 1
All other private	281	311	160	178	168	— 5
Public construction	15951	16346	11467	11765	11208	+ 2
Residential buildings	682	695	490	499	504	— 3
Non-residential buildings	5031	4997	3263	3243	2808	+16
Military facilities	1468	1456	1041	1032	1032	+ 1
Highways	5287	5521	4687	4894	4884	— 4
Sewer and water systems	**1489**	**1448**	**851**	**828**	**888**	**— 4**
Public service enterprises	664	701	375	396	324	+16
Conservation and development	1034	1260	591	720	648	— 9
All other public	296	268	169	153	120	+41

* Revised

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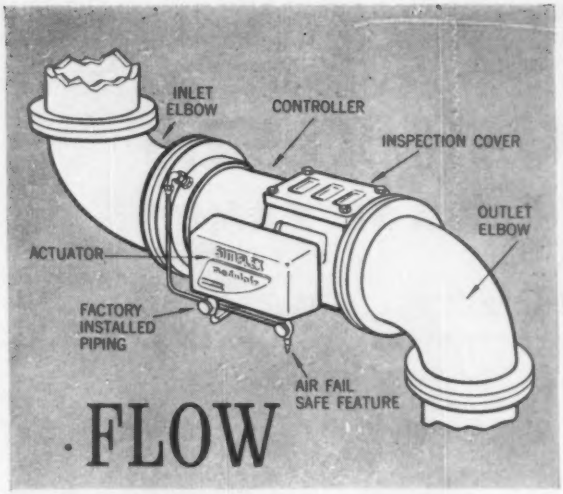

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Meetings

WHAT WHEN WHERE

1961

APRIL							MAY							JUNE						
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June 4-9—Detroit, Mich. (*Cobo Hall*) A.W.W.A. ANNUAL CONFERENCE. Secy., R. J. Faust, 2 Park Ave., New York, N. Y.

June 5-7—Tuscaloosa, Alabama (*University of Alabama*) ALABAMA WATER & SEWAGE ASSN. Secy., E. J. Finnell, Jr., Univ. of Alabama, University, Ala.

June 5-7—Pullman, Wash. (*Washington State University*) 7th SEWAGE WORKS SCHOOL.

June 6-8—Morgantown, West Virginia (*West Va. University School of Mines*) SIXTH ANNUAL APPALACHIAN UNDERGROUND CORROSION SHORT COURSE. Write: Mr. John H. Alm, Dearborn Chemical Co., 2 Gateway Center, Pittsburgh 22, Pa.

June 7-8—Harwichport, Mass. (*Snow Inn*) NEW ENGLAND WATER POLLUTION CONTROL ASSOCIATION.

June 7-9— Springfield, Ill. (*Leland Hotel*) CENTRAL STATES SEWAGE & INDUSTRIAL WASTES ASSN. Secy., Scott E. Linsley, 2400 Childs Rd., St. Paul 6, Minn.

June 7-9—Okoboji, Iowa (*The New Inn*) IOWA SEWAGE & INDUSTRIAL WASTES ASSN. Secy., L. F. Skorczeski, 207 S. 15th Ave., Marshalltown, Iowa.

June 11-15—New York, N. Y. (*Hotel Commodore*) 54th ANNUAL MEETING AIR POLLUTION CONTROL ASSOCIATION.

June 14-16—Cleveland, Ohio (*Statler-Hilton Hotel*) 35th Annual Meeting OHIO WATER POLLUTION CONTROL CONFERENCE. Write: Mr. E. B. Ransom, Secy., 101 North High St., Columbus.

June 15—Portsmouth, N. H. (*Wentworth-by-the-Sea*) NEW ENGLAND WATER WORKS ASSOCIATION.

June 19-21—New Brunswick, N. J. (*Rutgers University*) Short Course: Analysis of Water and Sewage, Contact Dean, College of Engineering, Rutgers, The State University, New Brunswick, N. J.

June 19-21—New Brunswick, N. J. (*Rutgers University Department of Sanitation*) Rudolfs Research Conference: "Public Health Hazards of Microbial Pollution of Water." Write: Dr. H. Heukelekian, Chairman, Dept. of Sanitation, Rutgers University, New Brunswick.

June 19-23—New York, N. Y. (*Manhattan College*) Sixth Course on Bio-Oxidation of Organic Wastes Theory and Design. Write: W. W. Eckenfelder, Civil Engineering Dept., Manhattan College, New York 71, N. Y.

June 19-30—Cincinnati, Ohio (*Robert A. Taft Sanitary Engineering Center*) Training course: "Aquatic Biology for Engineers." Write: Chief, Training Program, Robert A. Taft Engineering Center, 4676 Columbia Parkway, Cincinnati 26, or to PHS Regional Office.

June 20-22—Wernerville, Pa. (*Galen Hall Hotel*) PA. SECTION A.W.W.A. Secy., L. S. Morgan, 413 National Bldg., Greensburg.

June 20-23—Brighton, England. Annual Conference—The Institute of Sewage Purification.

June 27—Wayne, N. J. (*North Jersey Country Club*) N. J. SECTION A.W.W.A Secy., A. F. Pleibel, R. D. Wood Co., 683 Prospect St., Maplewood.

July 16-21—New Brunswick, N. J. (Rutgers, The State University) Summer Training Institute sponsored by the U. S. Public Health Service. Courses will include air pollution, radiological health, water quality management. Write: Sylvan C. Martin, Regional Engineer, U. S. Public Health Service, 42 Broadway, New York City 4.

July 24-28—Cincinnati, Ohio (*Robert A. Taft Sanitary Engineering Center*). Short Course: Recent Developments in Water Bacteriology. Write: Chief, Training Program, Robert A. Taft Sanitary Engineering Center, 4676 Columbia Parkway, Cincinnati 26, or to PHS Regional Office Director.

Aug. 7-9—University Park, Pa. PA. WATER WORKS OPERATOR'S ASSN. Secy., Harry A. DeWire, 29 Chestnut St., Lewistown, Pa.

Aug. 9-11—State College, Pa. (*Pa. State University*) PA. SEWAGE & INDUSTRIAL WASTES ASSN. Secy., J. R. Harvey, c/o Pa. Dept. of Health, 996 S. Main St., Meadville, Pa.

Aug. 20-25—Blacksburg, Virginia (Virginia Polytechnic Institute) Annual short school for water works, sewerage and industrial wastes personnel. Write: Prof. W. A. Parsons, Sanitary Engineering, Holden Hall, Virginia Polytechnic Institute, Blacksburg, Va.

Sept. 3-8—Chicago, Ill. AMERICAN CHEMICAL SOCIETY, Div. of Water and Waste Chemistry.

Sept. 11-13—Louisville, Kentucky (*Brown Hotel*) KENTUCKY-TENNESSEE SECTION A.W.W.A. Secy., Harold F. Mount, Preston Street Road Water Dist. No. 1, 5400 Preston Highway, Louisville, Ky.

Sept. 12-Oct. 5—New Brunswick, N. J. (*Rutgers University*) Short Course: Water Works and Filter Plant Operation. Contact Dean, College of Engineering, Rutgers, the State University, New Brunswick, N. J.

Sept. 13-15—Saranac Lake, N. Y. (*Saranac Inn*) N.Y. SECTION A.W.W.A. Secy., Kimball Blanchard, Neptune Meter Co., 2222 Jackson Ave., Long Island City 1.

Sept. 13-15—St Paul, Minn. (*Hotel Lowry*) NORTH CENTRAL SECTION A.W.W.A. Secy., Carl A. Flack, Water Dept., 216 City Hall, St. Paul 2, Minn.

Sept. 17-21—Poland Spring, Maine. Annual Convention NEW ENGLAND WATER WORKS ASSOCIATION.

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News of Suppliers

New York Air Brake Co. Negotiates to Purchase B-I-F Industries

Earl H. Bradley, President of B-I-F Industries, Inc., has announced that his company and The New York Air Brake Company have been negotiating an agreement under which New York Air Brake would purchase the assets and business of B-I-F. An agreement in principle has been approved by the Boards of Directors of both companies. Negotiations leading to a definite contract are continuing. When that contract has been agreed upon, the proposed transaction will be submitted to the stockholders at a special meeting called for the purpose. The notice of the meeting will be accompanied by a full explanation of the proposed action. It is expected that this meeting will be held during late May or early June.

If this plan is approved, the operation now conducted by B-I-F Industries, Inc. will be continued by the B-I-F Industries Division of The New York Air Brake Company. It will operate with the same management, the same employees, and in substantially the same manner as B-I-F Industries, Inc. does now, manufacturing in Providence and selling through the same field offices and representatives in the United States and in foreign countries.

Dorr-Oliver Reports Progress In 1960

The reduction in operating cost and the completion of important research and development projects now beginning to affect earnings was attributed to the improvement and increase of incoming business, according to L. R. Boling, President, Dorr-Oliver Incorporated.

Boling said this in the recently released Dorr-Oliver Incorporated 1960 Annual Report. The report told of a 29 per cent increase in incoming business.

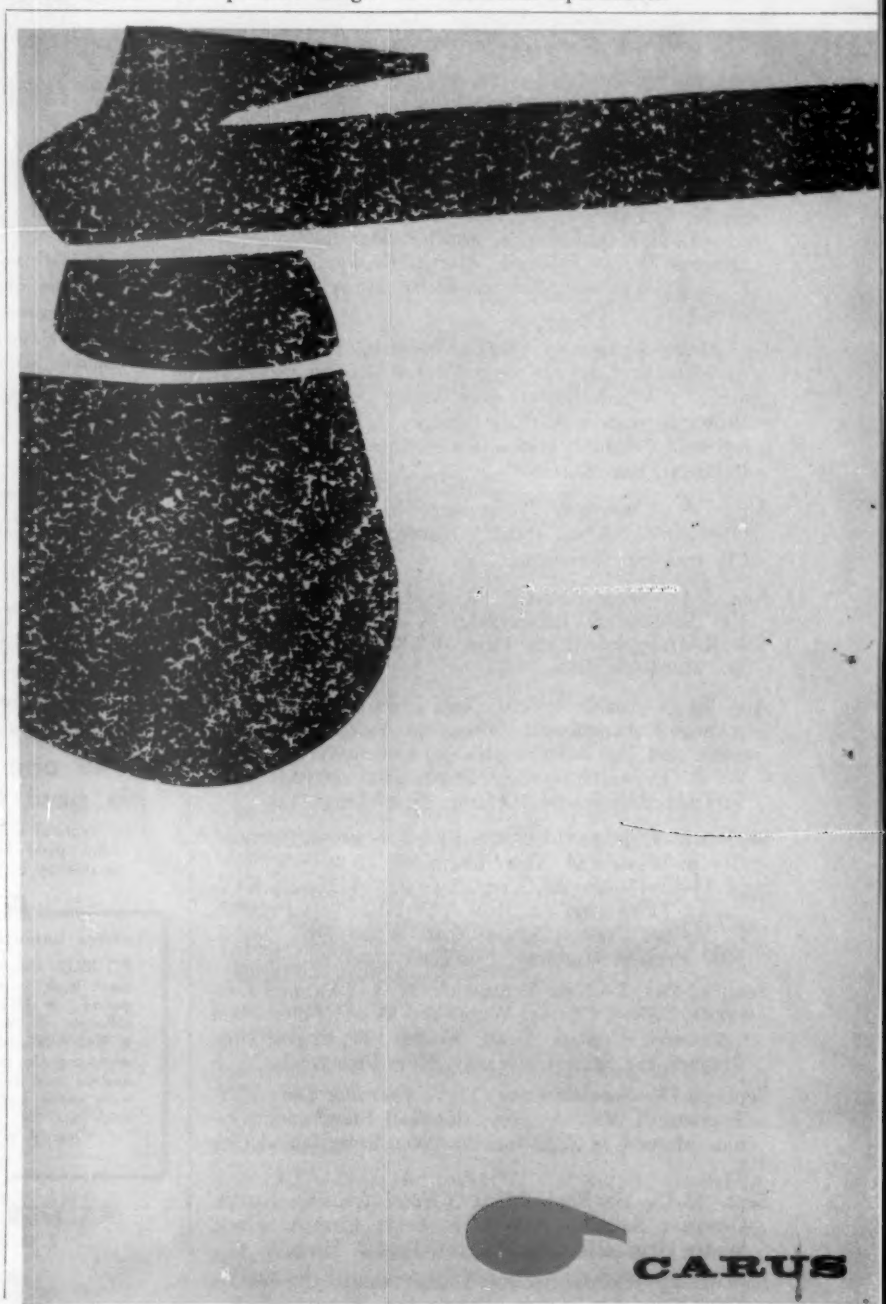
"The increase in incoming business to slightly over $54 million from less than $42 million in 1959, occurring in the face of a generally downward movement in the economies of both the United States and Canada, was particularly significant," Boling said.

He also noted that earnings of 61c per share were a substantial improvement over the 2c per share earned in 1959.

Kemmer Joins American Well Works

The appointment of Adam J. Kemmer as Vice-President in charge of research and new product design is announced by S. A. Karlin, President of the American Well Works, Aurora, Illinois, engineers and manufacturers of pumping, mixing, waste and water treatment equipment.

Mr. Kemmer comes to his new position with years of experience with American Telephone, Allied Chemical, and as design and division manager of Dorr-Oliver's sanitary and industrial departments.

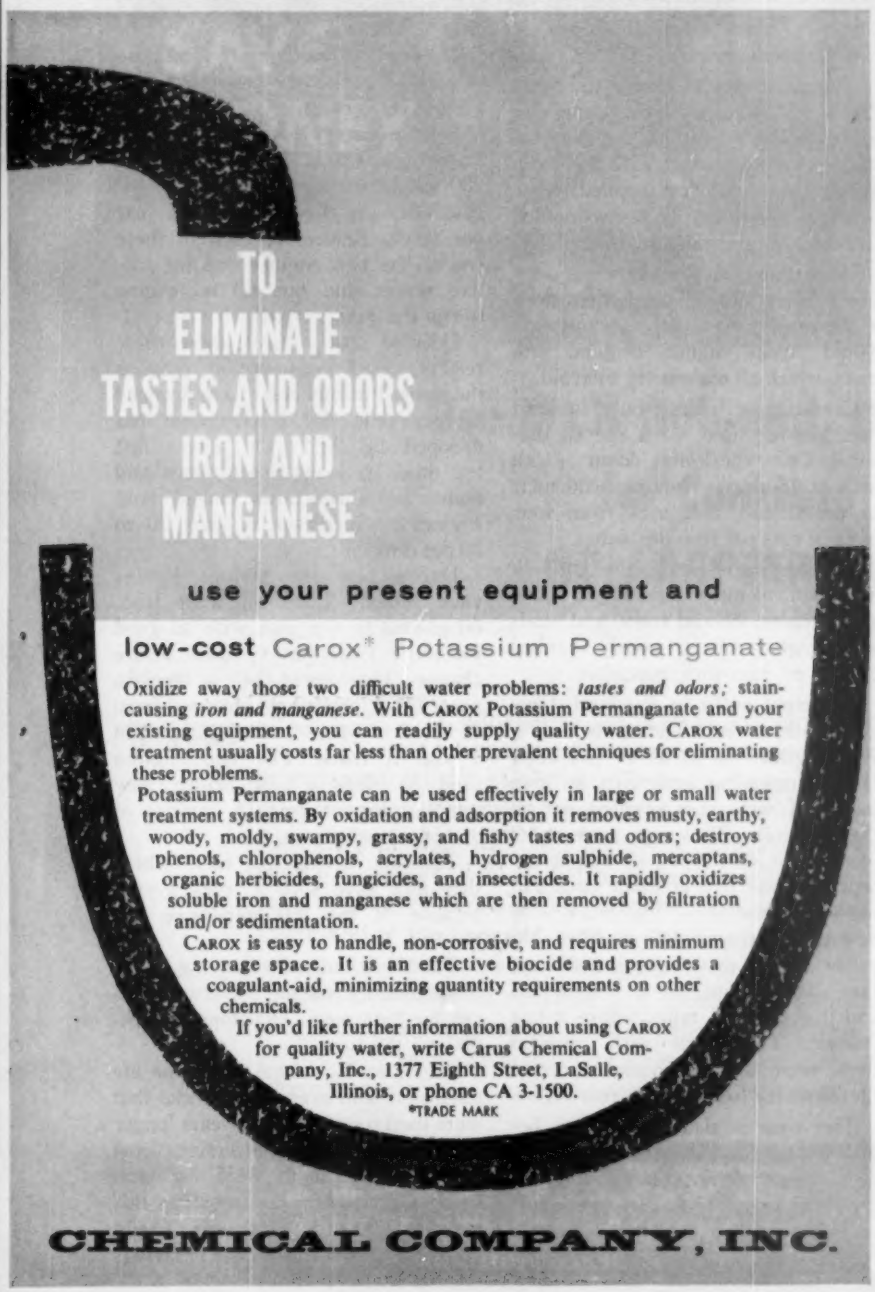


Darling Valve Enlarges Foundry

A newly equipped bronze foundry having a melting capacity of 12,000 pounds per day has recently been put into operation by Darling Valve & Manufacturing Company, Williamsport, Pa. The modernized foundry almost doubles the daily capacity of the old foundry.

Thomas C. Jester, Chief Engineer of Darling, states that the latest equipment provides better quality material; closer control of analysis is possible. There is less dross and impurities, cleaner pouring, and cleaner metal produced. With closer temperature control, the metal is poured as soon as the charge reaches pouring temperature. This avoids overheating and gas pick-up. Greater density in the metal structure results in an increase of approximately 10% in strength. A new sand-handling system also has been installed. A bucket elevator with aerator and a conveyor belt distribution system services five hoppers. One hopper feeds a flask filler; the other four hoppers service molding machines. Increased and improved production has resulted from this operation.

Darling's modernized foundry can handle up to 1000-pound castings. It is now producing valve parts such as seat rings, stems, bodies, sleeve bearings, disc rings, solid discs, wedging mechanisms, yoke and clamp nuts. Parts produced for Darling hydrants include nozzles, operating nuts, and drain rings.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Potassium Permanganate can be used effectively in large or small water treatment systems. By oxidation and adsorption it removes musty, earthy, woody, moldy, swampy, grassy, and fishy tastes and odors; destroys phenols, chlorophenols, acrylates, hydrogen sulphide, mercaptans, organic herbicides, fungicides, and insecticides. It rapidly oxidizes soluble iron and manganese which are then removed by filtration and/or sedimentation.
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If you'd like further information about using CAROX for quality water, write Carus Chemical Company, Inc., 1377 Eighth Street, LaSalle, Illinois, or phone CA 3-1500.
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Link-Belt Has Unusual Exhibit at AWWA Convention

Link-Belt's participation at the forthcoming American Water Works Association convention at Cobbo Hall, Detroit, will be highlighted by a pactorial display of the company's equipment as it is applied in the largest water filtration plant in the world. This giant installation, Chicago's Central District Filtration Plant, will have a daily flow of 960 million gallons and will serve both the Central and North water dictricts of Chicago.

In addition the company's exhibit area will contain transparencies that show Link-Belt circuline and straight-line sludge collectors used in water clarification; vertical and horizontal slow mixers for flocculation; flash mixers; disc and drum screens; traveling water screens; and chemical feeding and handling equipment.

Badger Meter Subsidiaries Merge

Consolidation of Precision Products, Inc., a Tulsa subsidiary of Badger Meter Manufacturing Co., Brown Deer, Wis., with Counter and Control Corporation, Milwaukee, another company subsidiary, has been announced by J. O. Wright, President of Badger Meter Manufacturing Co.

Effective April 17, the combined organization will be named Precision Products & Controls, Inc., and will be housed in new facilities located at 6116 East 15th Street, Tulsa.

Precision Products is a designer and manufacturer of mechanical timing devices, time switches, instruments, components and small precision parts. These parts include automatic screw machine products, precision gears and precision stampings.

Counter and Control markets automatic recycling circuit controls for industrial machinery and processes.

Keep 'em Rolling

by

C. G. Cunningham

■ Did your department get one of the booklets Ford Motor company distributed? It's entitled, "The Big Plus—Seat Belts". Ford has sent out over 4,000 of these booklets on specific requests from governmental and business fleet operators. This booklet advises fleets how seat belts can offer a real advantage to the user and to the firm that installs them on its vehicles.

City and state groups have taken to the benefits of using seat belts quicker than most businesses. Have *you* started using seat belts yet on your water and sewage maintenance trucks?

Corroded, frayed or partially broken battery, starter and generator cables can be a good indication that the interior metal strands have become brittle, and that the entire cable is apt to break. Cables in this condition should be replaced on all of your department's rigs. This condition breeds high resistance in the circuits which can result in eventual starting failure if not corrected.

Crawler treads are easier to adjust if you dab a little thread oil on the adjusting screws every month. This keeps the screws free moving and corrosion proof. A squirt from a can of rust proofing will do the same job.

Studebaker will bring out a new diesel equipped truck this fall. Production is set for June at South Bend. The Studebaker truck will be in the 23,000 GVW class with a Detroit Diesel 4-53 four-cylinder engine. The pair have been in test since 1958 Studebaker says. Many of these same engines have been used as repowering engines in many types of applications. The Diesel engine is well known for its fuel economy, long life and less costly maintenance and repair.

Have you tried crosscutting on your truck tires? Crosscutting is simply a series of small slashes or cuts across the tire tread.

But these slashes give a tire hundreds of running inches of tiny squeegee like edges that increase the tire's gripping contact with the road. When the brakes are applied, these squeegee edges take on a saw-toothed pattern and grab any road available.

Why don't tire makers crosscut tires? First, not all truck tires need it. Second it costs money, and that would mean higher original tire costs, which all makers try to avoid.

Crosscutting is done on a finished tire, new or used, on a special machine. One type knifes down 5/16th inch at 15 degrees off perpendicular to the thread, and uses from four to eight cuts per running inch.

Crosscutting is especially good in mountain country where you have steep grades, ice and snow, and roads with high crowns, poorly banked curves or rain-slick macadam.

A freight outfit in Portland, Oregon made a test. The route was a 7-mile grade of 10 to 14 per cent. It was snowing and two to five inches of wet snow covered ice on the last mile. Two rigs were used, identical in size, type and weight except that one had crosscut tires and the other new tires. The truck with new tread tires tried first. After 200 yards in rear drive only it lost traction. Then front drive was added and it got to 6½ miles before it lost traction. The truck with crosscut tires went up the grade smoothly the first try using only rear drive.

Tire wear is also reported up, because the cuts permit greater road contact, more even flexing and less sidewall strain. Most tire specialists in larger towns can handle crosscutting for you. Ask your tire supplier about crosscutting.

Have you considered Liquid Petroleum (LP) gas for your truck fleet? Whether you drive over the road, door to door or off road, you should look into the possibilities of LP gas conversion.

A case history: A ready-mix operator in Norfolk has converted its 200 gasoline truck mixer fleet to LP gas. They say they save $450 a year per truck. Remember each of these trucks has two engines one for motive power and one 60 hp engine to run the mixer.

Detailed cost records show these results: Fuel consumption remains the same. But fuel *costs* have dropped 40 per cent. Oil consumption has dropped by 90%. Oil filters last ten times as long. Spark plugs and points last three times longer. And engine life increases at least 20 to 30 per cent.

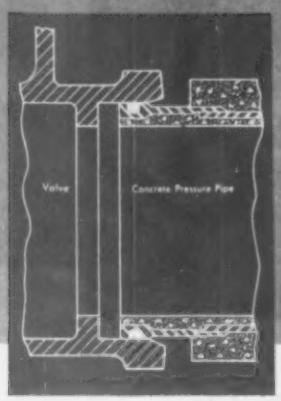
Here's how the savings figures were tallied: Lube oil went from 60 gallons to 6 a year with oil good for more than 10,000 miles before change. That saved $41 a truck a year. Oil filter changes dropped from 15 to 2 a year, a savings of $38 a year a truck. The two engines used 36 plugs a year before, now use 12 plugs a year. A savings of $12.50 a truck a year.

The big savings is fuel, where they now save $360 a truck a year because of the less expensive LP gas fuel.

This isn't the end of savings. The maintenance crew for 200 trucks was cut by four men. This lopped $18,000 off the payroll.

Added savings came on engine life extension, and even some trucks that were used for one or two years longer than normal. The conversions cost this company about $475 for each truck. Current savings amortizes this expense over the first year. Could an LP gas conversion offer savings to your truck fleet?

HOW TO SAVE MONEY



Cross section drawing to show position of concrete pipe spigot entering the hub of valve.

Use M&H Hub-end, O-ring Valves for Concrete Pipe NO ADAPTERS NEEDED

Eliminating the need of adapters when installing a valve in a concrete pressure pipe line saves both the purchase price and the installation expense of adapters. For a large size valve this often amounts to hundreds of dollars. That is why water works management, engineers and municipal officials are welcoming the advent of a valve with special hubs for use with concrete pipe. This valve employs an O-ring gasket to connect the valve hub directly to the spigot end of the concrete pipe. It was developed and now is manufactured by M&H Valve and Fittings Company.

This new valve for concrete pipe meets AWWA standards in every respect and is furnished in sizes 12″ through 42″. The valve gaskets are the same as the gaskets used for concrete pipe joints. For additional information, write for illustrated descriptive Circular No. 26.

M&H VALVE
AND FITTINGS COMPANY
ANNISTON, ALABAMA

A WALWORTH SUBSIDIARY

EQUIPMENT IN THE NEWS

For further information on products or services please use reader service card.

Municipal Vehicles

601

Improvements to its line of gasoline and electric-powered utility vehicles have been announced by this manufacturer. The 1962 line features a greater range of power and more versatility through the modification of existing, and the addition of new, body styles.

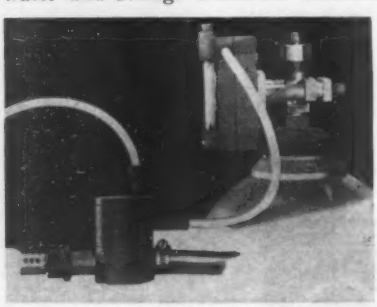
Municipal service is one of the many applications for the gasoline - powered vehicles: parking meter patroling, street cleaning, insect control spraying, park maintenance, garbage collection, building inspection, gas and water meter reading, etc. Available with 9 or 18-hp Super Husky die-cast aluminum engine.—Cushman Motors, subsidiary of Outboard Marine Corp.

Also Available—
Free literature describing the latest products and services offered the water and sewage works industry.
Information begins on page 101A.

Compact Gas Chlorinator

602

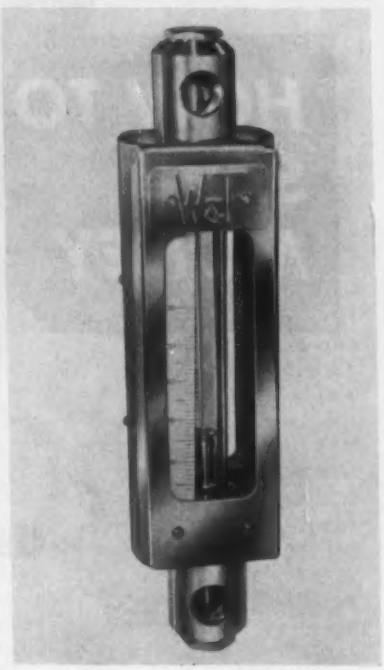
A compact chlorinator that feeds up to 50 lbs per 24 hours in three ranges and which is applicable for small water and sewage treatment installations is offered.



The vacuum operated solution feed, gas chlorinator uses a positive spring opposed diaphragm regulator. Flow adjustment is manual with a single rate valve. The chlorinator mounts directly on the chlorine cylinder valve.—Capital Controls Co., Inc.

Variable Area Flow Meter

603



An improved version of its variable area flow meter for fluid metering, identified under the trademark of "Verea-Meter", has been announced by this manufacturer. It is available in glass-tube and metal-tube models.

Glass-tube capacities with standard floats are 0.25 to 310 gpm of water, or 1.1 to 1300 scfm of air, against up to 350 psig and 400° F. Tube diameters from ⅜ to 3 in., with scale lengths of 5 and 10 in.—Wallace & Tiernan, Inc.

Steel Sidewalk Doors

604

A trend toward location of water and sewage system vaults and access entries under sidewalks and walkways keeps gaining favor, in view of the many inconveniences associated with the street and manhole covered access to underground installations.

The steel doors offered by this manufacturer are especially adaptable for underground pumping stations, valve operating areas and the like. The spring assisted doors can be opened easily by one man. Door tops and chains serve as pedestrain protection.—The Bilco Co.

CONTINUED ON PAGE 94A

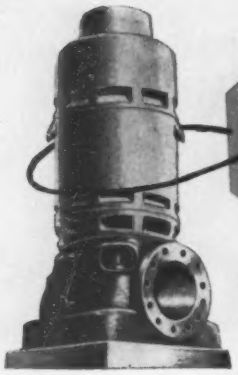
Solve peak-load and standby problems! F-M's exclusive O-P Diesel Generating Units provide *full* power in 15 short seconds . . . *from a cold start!* They need no spinning reserve. Use no power till you use them! The reason? Our exclusive O-P (Opposed-Piston) design. Two pistons in one cylinder function from a *single* combustion. This minimizes *vibration* . . . produces fine *balance, smooth* power to peak the generator—in just 15 seconds! F-M Opposed-Piston Diesel Generating Units are available with automatic or manual controls. Produce up to 2500 kw per unit. They may be linked in multiple units for peaking, standby duty . . . or dead load pickup! You can't buy better—or more economically.

For full details or custom specifications, write today to: **Mr. S. K. Howard; Diesel Division; Fairbanks, Morse & Co.; Beloit, Wisconsin.**

FAIRBANKS MORSE

A MAJOR INDUSTRIAL COMPONENT OF

FAIRBANKS WHITNEY



Another Important FIRST By "VERTI-LINE" PUMPS...

HIGH-TEST "MOLY" IRON NOW "STANDARD" IN ALL Verti-Line® Pumps

Again Layne & Bowler sets new standards of quality construction for the pump industry... *longer-life Molybdenum-Iron is now "standard" construction—at no extra cost—in* ALL *"Verti-Line" pump cases and other cast iron parts!*

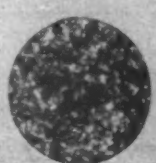
"Moly" iron has a more uniform grain structure, is far more corrosion-resistant than is the gray iron normally used in pump construction. Therefore, you get longer operating life, lower maintenance costs, when you specify Layne & Bowler "Verti-Line" Pumps!

COMPARE!

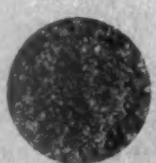
GREY IRON

MOLY IRON

▶ **These Photomicrographs,** both made at exactly the same enlargement (100x), show the structure of gray iron (left) vs. "Moly" iron (right). Note the long "stringers" of soft graphite characteristic of gray iron—stringers that weaken the metal and lead to early breakdown of the iron matrix. Note (right) how "Moly" iron is far more homogeneous, with uniform distribution of the iron matrix for longer pump life.



GREY IRON



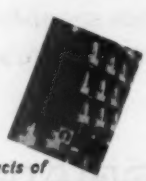
MOLY IRON

▶ **These "Fractures"** (views across fractured surfaces) clearly show the much coarser grain of gray iron (left) vs. the uniformly fine grain of "Moly" iron (right.) Although Layne & Bowler's fine-grained "Moly" iron assures much longer pump life than the gray iron used in other pumps, *you now pay nothing extra for this important "Verti-Line" advantage!*

Layne & Bowler has its own modern foundry—therefore can standardize its foundry runs to "Moly" iron techniques *at no extra cost to you.*

And if your operations are extra tough, "Verti-Line" pumps are available in special "Moly" irons having a Brinell as high as 350... a Tensile as high as 50,000 psi!

Remember—"Moly" iron is just one of many major pump advancements built into every "Verti-Line" pump—advancements that assure top performance for your pump dollar when you specify "Verti-Line" Pumps!



For more details on the many "Verti-Line" advantages, write for Bulletin #200.

Verti-Line Pumps are exclusive products of

LAYNE & BOWLER PUMP COMPANY

LOS ANGELES 22

New York 20, N.Y. • Chicago, Ill. • Hastings, Neb. • Monroe, La. • Farwell, Texas • Twin Falls, Idaho • Fresno, Calif.

Equipment News

CONTINUED FROM PAGE 92A

Differential Analyzer

605

A new differential AutoAnalyzer® for continuous chemical analysis, with automatic blank or interference compensation, that can detect trace materials to parts per billion with an accuracy of 1%, is announced by the manufacturer.

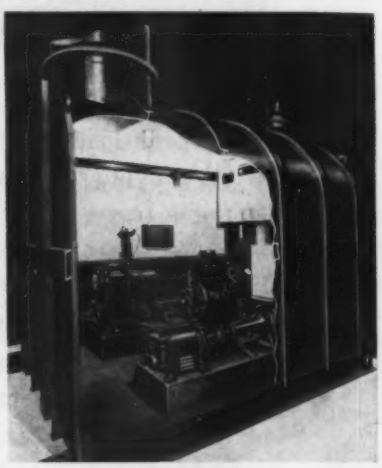
The new analyzers are available for single or multiple component determinations, for laboratory or plant use. Among the many materials analyzed are cyanides, silica, phosphates, iron, chloride, sugars, aluminum, sulfates, copper, etc.—Technicon Controls, Inc.

Packaged Pump Station

606

A new rectangular-shaped packaged pump station, designated the "Tex-Quad", has been announced by Tex-Vit Manufacturing Co.

The new addition to this company's line of sewage and industrial lift station features a rectangular steel shell which offers extra floor space for future expansion of its pumping unit equipment.



Other features include: movability, made possible by exterior lifting hooks mounted on the stations steel shell; twin overhead trolley rails for easy removal or installation of pumps and motors; variable speed pumps to match capacity to rate of sewage inflow; and three-coat tar epoxy for maximum protection against corrosion.—Tex-Vit Manufacturing Co.

Sludge Flowmetering System

607

A new flowmetering system designed to withstand the continuous passage of sewage sludge and to provide an accurate linear measurement and record of its flow, has been announced by this manufacturer.

The system comprises an obstructionless flow-primary element mounted in the sludge line and a transistorized recorder. The primary element operates on the principle of electromagnetic induction.

A unique feature of the sludge flowmeter is its automatically-controlled heating which prevents grease build-up within the tube, and assures uninterrupted accurate flow measurement.—Fischer & Porter Co.

Corrosion-Resistant Vinyl Coating

608

A new high build vinyl coating, Amercoat No. 99, announced by this manufacturer, can be applied with either conventional or airless spray equipment.

Applied by airless spray, one cross sprayed coat easily produces a dry film thickness of 6 mils. With conventional equipment, dry film thickness of 5 mils is obtained with just two coats.

This coating is recommended for use on tank exteriors and all types of structural steel. It may be teamed with one coat of an inorganic zinc silicate such as Dimetcote.—Amercoat Corp.

Compact Table Feeder

609

A new self-contained, easily portable table feeder for practically any granular or powdered dry material has been announced by the manufacturer. The lightweight construction (only 150 lbs.) of the Model 23-02 allows installation in any convenient location, such as a laboratory bench.

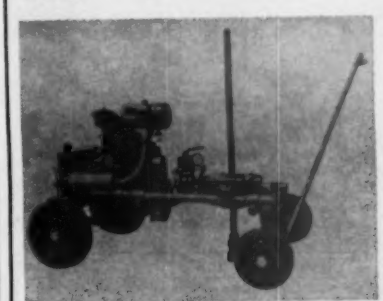
A feed scroll and adjustable gate assure uniform volumetric feeding, regardless of changing flow characteristics of the material. Micrometer gate adjustment provides a 20:1 feeding range between minimum and maximum for which the feeder is geared.—B-I-F-Industries.

CONTINUED ON PAGE 96A

Payne Dean & Company, Clinton, Conn.

Truck-mounted, hydraulic valve operators provide fast, safe control of 10″ to 60″ valves

One Man Control of Speed and Torque on Gate Stem with Indication. Two Safety Control Devices.



4-Speed Electric Motor Gatenders. For Floor-Stand and Under Floor Operation. 1 to 5 HP 10" To 36" Valves.

Portable Engine Driven Gatenders, For Valves 10" to 36". All Hydraulic Operation. Two Safety Features.

LUDLOW-RENSSELAER

TROY, NEW YORK

VALVES—HYDRANTS

Entering our second century of growth through quality and service

100th

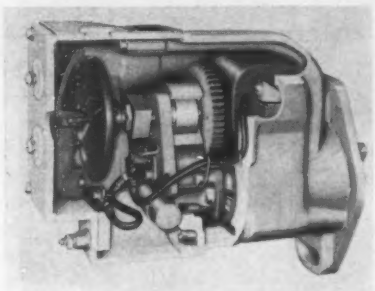
Equipment News

CONTINUED FROM PAGE 95A

Heavy-Duty Low-Tension Ignition System

610

A new heavy-duty low-tension ignition system for gas and gasoline engines has been developed by this manufacturer.



The only current inside the magneto is low voltage, resulting in longer life of the unit and its component parts. This new unit is intended for use on large industrial engines where continuous duty is of prime importance. Typical uses are oil field, irrigation and municipal water and sewage plant applications.

The system includes transformers of either the standard or shielded type. Transformers—one for each cylinder—are mounted on the engine block.—Magneto and Engine Accessories Div., Fairbanks, Morse & Co.

High Pressure Valves

611

A new line of high pressure valves has been introduced by this manufacturer. The Series RB split-body, barstock control valve is designed especially for handling high pressure liquids and gases.

Built to 2500 lb. ASA rating, these valves are suited for 6000 psig cold working pressure. They are available in both straight-thru and angle construction, sizes ½ in. thru 1 in., with a variety of end connections.—Conoflow Corp.

Sewage Digester Floating Cover

612

A new type of sewage digester floating cover consisting of rectangular steel plates welded in the field into a single deck without trusses, to which a protected insulation is directly applied, is now available. The steel plates are ¼ in. thick. Insulation is of 1½ in. thick fiberglass material.

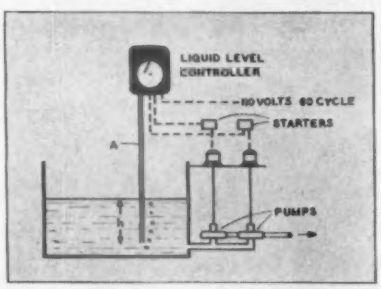
A weighted pontoon around the periphery is a structural member designed for torsion, bending and compression. A single roller guide banishes possible sidethrust on the tank wall. This "plate and pontoon" design minimizes tip and makes submergence impossible.—Infilco, Inc.

Packaged Level Control

613

Combining the familiar bubble tube method of measuring level and the reliability of electrical control, this manufacturer has introduced a "packaged" control unit for use in industrial processing and in water and sewage treatment plants.

Features of the instrument: ± 0.5 per cent accuracy; ranges from 0—10 in. of water up to 0—10 ft of water; no cleaning or servicing problems; simple to install, even in inaccessible locations such as reservoirs and underground tanks. It can be furnished as an indicator, a recorder, or a telemeter transmitter. All components are housed in a single instrument case, to which a bubble tube is connected.—The Foxboro Co.



Giant Size Shredder

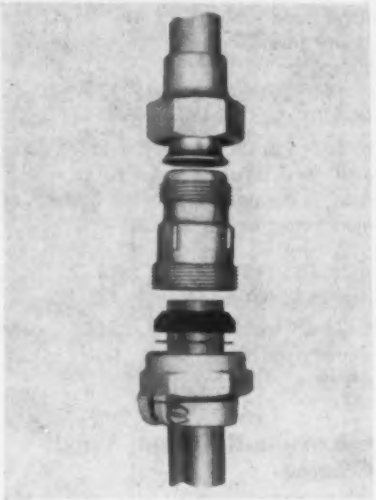
614

The Paul Bunyan "360" has a shredding capacity of 120 yds. per hour. Equipped with a 70 hp. engine and 9 ft wide hopper, it shreds, blends, mixes and aerates materials, rejecting stones, trash, etc., all in one operation. Adjustable sweep and deflector permits various textures of finished material which can be discharged into trucks or stock piles. —Royer Foundry & Machine Co.

Lead Pipe Couplings

615

A new type of couplings that provide a quick permanent connection of lead pipe to iron or copper has been announced by this manufacturer.



With the use of this coupling, connections to lead pipe are quick and easy. The pipe is not disturbed except for sawing and cleaning. The coupling locks on the pipe with a powerful, permanent grip and connects to copper tubing with a flare or solder joint or to iron pipe fittings with a threaded joint.—The Ford Meter Box Co., Inc.

Well Strainer

616

Exclusive V-shaped self-cleaning slot design permits maximum well delivery over long periods. The strainer's V-shaped slot is larger on the inside than on the outside, preventing sand and gravel entry. Any particle that enters a slot will pass through without choking it.

The V-shaped slot strainer allows for maximum development by removing silt, alluvium, clay and fine sand from around the outside of the strainer.—Cook Well Strainer Co.

End Suction Centrifugal Pump

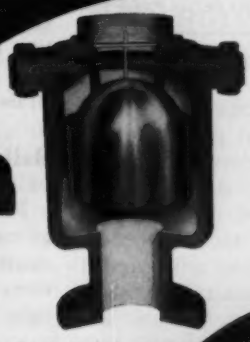
617

A double ball bearing end suction centrifugal pump has recently been announced by this manufacturer.

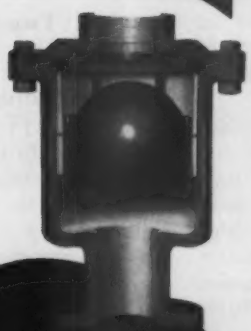
Equally suited for belt or direct motor drive, it has a capacity range of 10 gpm to 300 gpm and heads

CONTINUED ON PAGE 98A

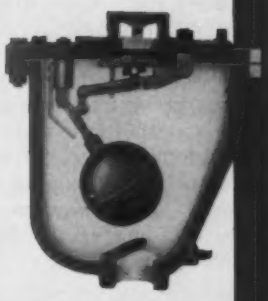
Crispin Pressure Air Valve.



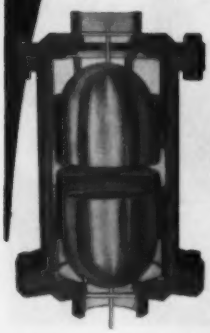
Crispin Air & Vacuum Valve with metal float.



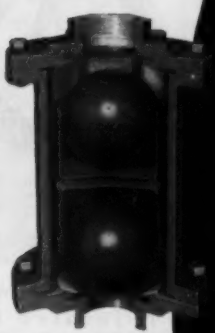
Crispin Air & Vacuum Valve with rubber float.



Crispin Universal Air Valve.



Crispin Negative Pressure Air Valve with metal floats.



Crispin Negative Pressure Air Valve with rubber floats.

the *Golden Anniversary* line

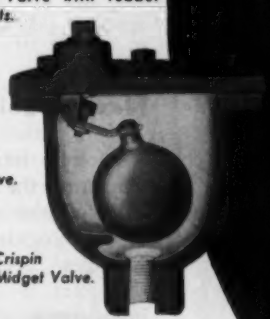
Crispin

AUTOMATIC *Air Control* VALVES

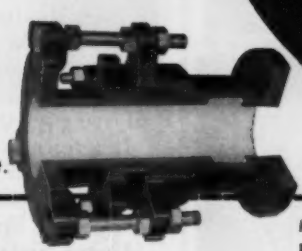
- Simplified construction
- Easy accessibility
- Maximum durability
- Minimum maintenance
- Efficient operation

Crispin Air Valves safely control air in lines handling liquids to maintain efficient operation—eliminate costly failures. That's why, for more than fifty years, water works engineers have made Crispin Air Valves first choice for dependability!

Crispin Sewer Valve.



Crispin Midget Valve.



Crispin Slip Joint.

Mail coupon for your free copy of this 28-page Crispin Air Valve Catalog.

AIR CONTROL VALVES FOR OVER 50 YEARS

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Company_____

Address_____

City_____ State_____

Title_____

Equipment News

CONTINUED FROM PAGE 96A

to 150 ft. Semi-open impeller is mounted on stainless shaft with precision taper fit for perfect alignment and easy removal.

"Back-pull-out" feature enables pulling working parts without disconnecting casing from piping. Stuffing box and split gland are standard, but mechanical seal is available at no extra cost. Pump is suitable for booster operation when suction pressure does not exceed 25 lbs.—The Deming Co.

Vertical Two-Stage Pumps

618

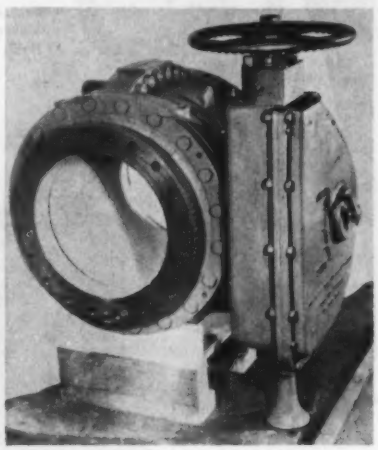
A new line of vertical, two-stage, split case centrifugal pumps, identified as the AJV Series, was recently introduced by this manufacturer.

Especially designed to reduce space requirement to a minimum, these pumps feature a case split parallel with the impeller shaft. The bearing housing supports, suction and discharge flanges are integral with the vertical base section of the case, thus allowing for removal of rotating element without disturbing either suction or discharge connections.—Aurora Pump Div., The New York Air Brake Co.

Ball Valve

619

Performing the same services as a cone valve, but considerably smaller in size and weight, Willamette List 26 Ball Valve is a drip tight valve that is used widely for



pump check, regulating and critically located shut-off applications. Available in 10 in.—42 in. sizes, 150 and 250 psi, with any type of operator.—Willamette Iron and Steel Co.

Flexible Joint Pipe

620

Recently introduced by this manufacturer, the USIFLEX® boltless flexible joint cast iron pipe is already recognized for its many advantages. Locked against pull-out, this joint is suited for underwater installations where speed and ease of assembly are very important. Its L-shaped gasket is self-sealing.

The new joint pipe is furnished in sizes 4 in. through 24 in. in nominal laying lengths of 18 ft.

In a recent installation, 1.450 ft. of 24 in. USIFLEX pipe was used for a supplemental water supply line across John's Pass, Pinellas County, Florida. —United States Pipe and Foundry Co.

Sludge Pump

621

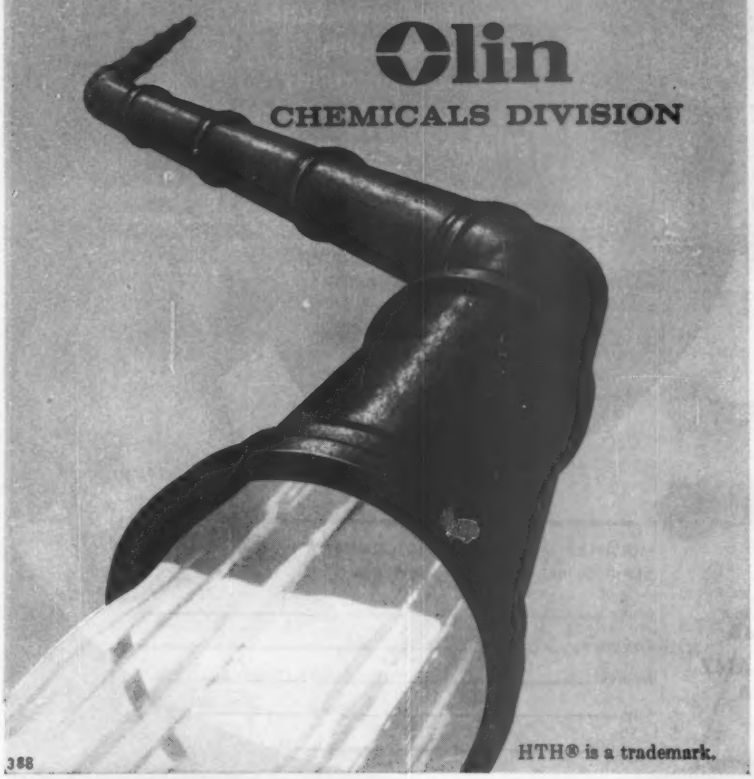
Marketed under the trade name of "Scru-Flo", this manufacturer's sludge pumps are sturdily con-

Chlorination, right down the line. Dry, easy-to-use HTH Tablets—the modern way to chlorinate new mains . . . kill bacteria, algae and fungi fast. They release dependable, highly effective chlorine quickly . . . dissolve slowly to last longer. Economical, too—one tablet sanitizes many feet of pipe. HTH Tablets protect reservoirs, wells and filtration equipment, too. Come in convenient cans, pails and drums. Write for literature: **Olin Mathieson, Baltimore 3, Maryland.**

Here's to Health . . . **HTH**

Olin

CHEMICALS DIVISION



388

HTH® is a trademark.

structed (of cast-iron), mounted on a fabricated steel base, and available with a belt and enclosed varidrive for easy adjustment of pump capacity.

The heart of the pump is the hardened chrome helical screw, which rotates in a durable, rubber female helical shield. The screw action is likened to that of a continuous piston. A rag guard, strategically located, prevents rags from wrapping around the shaft. Capacities range from 75 to 400 gpm at heads up to 120 ft.—Chicago Pump Co.

End-Suction Centrifugal Pumps

622

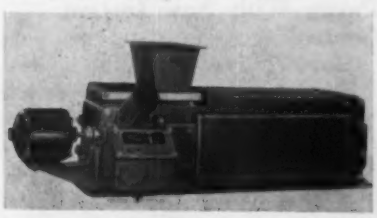
A new "packaged line" of Close-Coupled End-Suction Centrifugal Pumps has been announced by this manufacturer.

Complete disassembly without disturbing the suction or discharge piping minimizes the effort required for inspection and maintenance. Vertical centerline discharge makes these pumps self-venting, eliminating the possibility of vapor lock and providing smooth operation. Capacities range up to 400 gpm and heads up to 150 ft. Reduced space requirements and easier installation are other outstanding features.—Aurora Pump Div., The New York Air Brake Co.

Volumetric Feeder

623

The Merchen Volumetric is a manually controlled, belt-type feeder with arrangements to give feed rates of 3 to 3000 lbs. per minute.

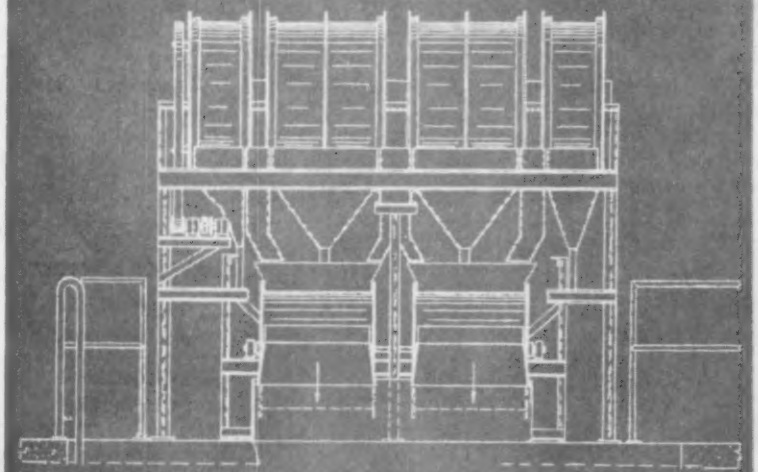


Available in models with 9 in. or 18 in. feed sections, it is designed to handle dry, free flowing materials ranging from flour to lead powder or powdered coal. By the addition of readily available weighing components, it may be converted to a gravimetric feeder. The overall construction of the feeder is of cast aluminum, except for the vertical gate, which is made of stainless steel.—Wallace & Tiernan, Inc.

CONTINUED ON PAGE 100A

NICHOLS "ROTO-PLUG"* SLUDGE CONCENTRATOR

CUTS SLUDGE DEWATERING COST 3 WAYS



It eliminates:

1. Sludge Conditioning Chemicals.
2. Expensive Chemical feeding & conditioning equipment.
3. High filter media maintenance costs.

The Roto-Plug accepts sludge "as is", providing economical, safe, clean operation!

Get the full Roto-Plug story—Write today for 4-page descriptive folder RP-100.

*Equipment Development Corp.

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Equipment News

CONTINUED FROM PAGE 99A

Steel Sewage Treatment Tank

624

A factory-fabricated small steel sewage treatment tank, identified as "RatedAeration SS", uses the aeration process of sewage purification originally developed by this manufacturer.

Its compactness, low cost and high efficiency make it the answer to sewage treatment problems for small communities, shopping areas, motels, factories, resorts, country, clubs, etc.

Completely odor and nuisance free, the unit can be installed above, or below ground, adjacent to, or away from buildings. Completely standardized and packaged, the unit incorporates a comminutor, aeration tank, forced air blowers, clarification compartment and a sludge air lift pump. Available in three sizes: 1000, 3000 and 5000 gallons per day.—Chicago Pump Co.

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HORIZONTAL
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NON-CLOG DRY PIT pump with double suction elbow and stand. Send for Bulletin 1850.5.
NON-CLOG WET PIT with cover. Single unit. Duplex models with alternating controls available. Send for Bulletin 1850.2.
PACIFIC NON-CLOG PUMP with motor, motor support bracket, suction elbow and stand. Send for Bulletin 1850.5.
HORIZONTAL NON-CLOG MODEL with flexible coupling. Send for Bulletin 1850.5.
Outstanding performance and long trouble-free service from every type. Pacific Non-Clog Sewage Pumps combine all desirable design features that assure efficient, economical and dependable operation and service.
Order now. ALL TYPES AVAILABLE FOR IMMEDIATE SHIPMENT.
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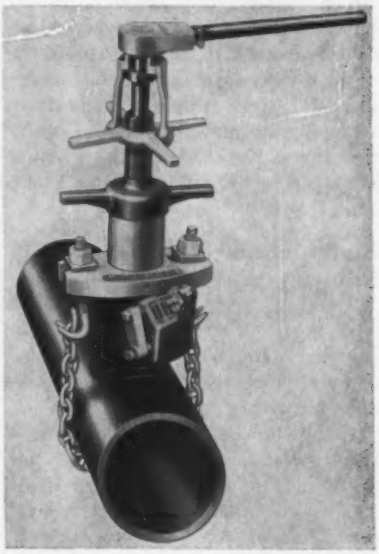
Pipe Drilling and Tapping Machine

625

The new Model B-100 is a double pressure chamber machine designed



for drilling, tapping and inserting corporation stops into water mains under full service pressure. Hand or power operation. Improved boring bar bearing design eliminates tool crawl and the resultant tool and tap tooth breakage. Improved tool attachment and driving method. Rigidity on the main is assured by new square shank chain hooks and square washer, which prevents twisting of the chain during tightening. —Mueller Co.

Pump With New Instant Control

626

Two-page Bulletin 08B9548 describes the manufacturer's ACAP pump equipped with a new instant control for variable capacity and head requirements.

Cross section diagrams show the operation of the pump's pneumatic control system built into the unit's body. The new system uses a pneumatically operated piston to replace the original gear train mechanism. The ACAP pump reduces flow by means of opening clearances, rather than valve throttling or slowing pump speed to improve mixing, eliminate plugging, save power, and reduce air binding.—Allis Chalmers Mfg. Co.

New Literature

AVAILABLE FREE

River Crossing Pipe

627

American Molox Ball Joint pipe for river crossings and other submarine service is the subject of a new catalog recently published by this manufacturer.

The 32-page catalog contains a detailed description of the joint, various applications and installation methods, dimension and weight tables and assembly instructions.—American Cast Iron Pipe Co.

Transite Pressure Pipe

628

8-page Bulletin TR-160A describes the advantages of Transite Pressure pipe for use in water mains.

Bulletin contains tabular data giving the sizes and weights of Transite asbestos-cement pressure pipe in the three available classes: 100, 150, and 200. Methods of manufacture, quality control, installation, and assembly are fully explained. Considerable emphasis is given the Ring-Tite method of assembly, illustrated through cut-away drawings.—Johns-Manville.

Light Weight Air Boring Unit

629

4-page bulletin illustrates and describes this manufacturer's light weight air powered boring unit, Model A-20, capable of augering 2¼ to 16 in. diameters.

The bulletin presents a capacity chart, and discusses various track and optional combinations. The A-20 consists of a 6 hp vane type air motor, 71.2 to 1 rear reduction, forward and reverse control valves, and standard Ka-Mo double track mounting. Range varies from close to 100 ft. of 2¼ in. hole to 42 ft. of 16 in. hole.—Kwik-Mix Co., Div. of Koehring Co.

Grease Flotation Unit

630

8-page Bulletin No. 260 B illustrates and describes the manufacturer's Grease Flotation Unit designed for the removal of greases and oils from sewage in primary settling tanks.

This pre-treatment assures successful secondary treatment processes. The unit removes greases and oils, produces simultaneous aeration and agitation, and oxidizes objectionable odors. Recommended applications: To existing overloaded plants; to new design for economy in secondary treatment; to tough or septic wastes preparatory to further treatment.—The American Well Works.

Hydraulic Actuation of Cylinder Operators

631

Three-page Specification Data Sheet recently issued illustrates and describes this manufacturer's Hydro-Pneumatic four-way Valve, Model 474-01, a pneumatic diaphragm-operated mechanism designed for hydraulic actuation of cylinder operators mounted on valves or controllers. It is especially suited for systems requiring a valve with positive thrust.—B-I-F Industries.

CONTINUED ON PAGE 102A

G-A CUSHIONED FLOWTROL VALVE

It's easier to operate a G-A Flowtrol Valve than it is to drive a car with power steering! The reason? Line pressure furnishes the power to open or close the valves. No manual effort, no handwheels, no motors, no levers are needed—regardless of size of valve or pressure. Just a "flick of the wrist" or press of a button will fully open or tightly close the valve.

Get all the facts in Bulletins W-8A and G-4.

Golden Anderson Valve Specialty Company

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New Literature

CONTINUED FROM PAGE 101A

Sewage Treatment Manual

632

Recently published Sewage Treatment Manual for use by consulting engineers and others engaged in specifying air and gas handling as required in sewage treatment and sanitary applications.

Contained in the manual is information necessary to select the size of and write specifications for air blowers needed in sewage treatment plants. Accessories most commonly required in sewage treatment plants are also covered for convenience.—Sutorbilt Corporation, subsidiary of Fuller Company.

Sludge Collectors

633

28-page Catalog 2746 illustrates and describes this manufacturer's Straighline sludge collectors.

The catalog contains engineering data on equipment for removal of sludge from rectangular settling tanks employed in the treatment of water, sewage and industrial waste. In addition, it offers tables that simplify selection of proper size of tank and a reprint of the "Ten States Standards for Sewage Works" specifications for sedimentation tanks, of particular interest to sanitary equipment engineers and consultants.—Link Belt Co.

Plug Valves

634

A new line of improved plug valves, the Oriseal, has been recently introduced. Easy turning is one important feature, even after prolonged idleness. In tests, a 2 in. Oriseal valve, at 125 psi pressure, was operated easily with a 12 in. wrench after prolonged use and then idleness. Sticking and freezing of the plug is virtually eliminated.

Top and bottom O-rings of equal size positively seal both ends of the plug to prevent leakage. Sealing at the port is provided by an O-ring in a groove around the outlet port. The entire surface of the plug is

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Obtain graphic records of liquid flow directly readable in million gallons per day or gallons per minute over various sizes of Parshall flumes. The same recorder can also be used with charts reading in feet and hundredths to record head or surface fluctuations in lakes, streams, wells. Write for free Bulletin 24.

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- prevents cave-ins
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Blunt safety-lever nut prevents damage, injuries. Ball-and-socket joints, plus lugs at each end, give quick set and tight grip at all angles. Nailing holes at both ends. Pipe sleeve adapts brace to any trench width. Overall closed lengths, with pipe, from 18" to 60", screw extensions from 7" to 10". Also available without pipe.

Get all facts, write for Mechanical Catalog

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TEMPLETON, KENLY & CO.
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coated with Teflon, assuring easy turning without lubrication or periodic maintenance. Sizes range from ¾in. through 2 in.—Mueller Co.

Asbestos Sheet Packing Material

635

An improved K & M Style 340 sheet packing material of compressed asbestos and synthetic rubber has been announced by the manufacturer. The new material has been tested successfully under simulated service conditions sealing against steam, water, petroleum oils, refinery gases and hydrocarbons. It meets Specification P1161A of ASTM Designation D1170-59T.—Keasbey & Mattison Co.

Vertical Sewage Ejectors

636

8-page Bulletin 800 explains in detail the features of vertical non-clog sewage ejectors designed for positive handling of raw, unscreened sewage in commercial buildings and industrial plants.—The Weinman Pump Mfg. Co.

Weighing Feeder for Dry Materials

637

4-page catalog recently issued describes this manufacturer's Model 37-02 Belt Gravimetric Feeder that continuously weighs and feeds any dry, flowable material at a fixed rate.

Ruggedly built, compact, and completely automatic in operation, it feeds a maximum of two cu. ft per minute over a 100:1 range within an accuracy of ± 1% of the set feed rate. It is especially suited for proportional feeding of solids with other solids or liquids.—B-I-F Industries.

Remote Controls for Valves

638

A new Design Manual on the remote control of valves has been published by this manufacturer.

The Manual, which gives complete dimensional data and selection information, is divided into three sections. Section 1 covers flexible shafting including remote operating terminals, valve couplings and intermediate connections; Section 2 covers exclusive rigid reach controls; and Section 3 covers the Stow 300 degree geared joint.—Stow Mfg. Co.

CONTINUED ON PAGE 104A

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New Literature

CONTINUED FROM PAGE 103A

Feeding, Proportioning or Batching

639

The manufacturer's powered feed regulating machines that automatically feed, blend and proportion materials continuously by weight, are described in six brochures. Bulletins 158 and 253 deal with the Feedoweight. Bulletins 375, 759, and 858 describe the Weightometer. Bulletin 851 covers both machines.—Merrick Scale Mfg. Co.

Cast Iron Pipe Joint

640

Eleven-page brochure describes in detail the features and advantages of American Fastite Joint Pipe, a double-sealing, single gasket type cast iron pipe joint for water, sewage, and other liquid service.

Typical installations, assembly instructions and tables on pipe, from 3 in. to 48 in. are included, along with recommended deflection tables.—American Cast Iron Pipe Co.

641

Protective Coatings

13-page General Bulletin CAC-11-958 describes the complete line of Coal-Tar Protective Coatings offered by this manufacturer.

Primarily moisture barriers and impervious corrosion proofers, the coatings are particularly suitable for application on buried or immersed steel and concrete structures. Because of their inherent resistance to water penetration, chemicals and stress conditions, these coatings find wide use in a variety of industrial, utility and municipal installations.—Allied Chemical Corp.

Fire Hydrants

642

20-page Catalog H100 presents the manufacturer's Model H100 hydrant. Catalog includes detailed illustrations of construction, mechanical drawings and approved installation and inspec-

You'll be amazed at NoDrip Plastic Coating savings

Instead of using expensive absorbent insulation or multiple coats of paint on cold pipes, tanks and air ducts, switch to NODRIP PLASTIC COATING to *permanently* stop condensation drip and corrosion! Cost is far less, application fast and simple. Applies like plaster with trowel or brush.

Non-toxic, odorless, non-flammable. Resists acids, alkalis, brine solutions or vapor. Use on metal, concrete, brick, plaster, tile. Stops condensation drip, rust and corrosion. 1 and 5 gal. cans or 55 gal. drums.

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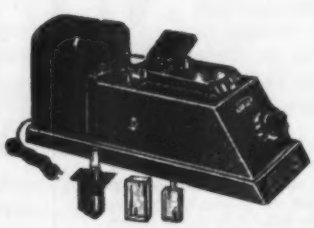

Can be used for any determination in which color turbidity can be developed in proportion to substance to be determined.

KLETT MANUFACTURING CO.
179 EAST 87th STREET • NEW YORK 28, N. Y.

tion procedures.

The Model H100 hydrant conforms to current AWWA specifications and is produced with 4⅝ in. and 5¼ in. internal valve openings, for water working pressures up to 150 lbs.—A. P. Smith Manufacturing Co.

Rotary Vacuum Blowers

643

4-page technical Bulletin S-RVS-159 covers the manufacturer's Series RVS rotary vacuum blowers. These are heavy duty, high speed, vertical type vacuum blowers designed specifically for continuous service as single units in smaller volume applications requiring vacuums to 20 in. Hg.

Bulletin describes construction, lubrication, sealing and special features of the blowers. It includes drawings and specifications.—Roots-Connersville Blower Div., Dresser Industries, Inc.

Concrete Pressure Pipe

644

The Story of Concrete Pressure Pipe, a 24-page booklet, illustrates and explains the principle of prestressing, and how prestressed pipe is manufactured. It also gives the procedures for installing and tapping pressure pipe, and facts about its principal uses. A complete table of sizes, weights and normal operating heads for each type of pipe used for water transmission and distribution lines, subaqueous intakes and outfalls, and sewage force mains is included.—Price Brothers Co.

Ball Valve

645

6-page brochure gives full information on the design, construction details and principle of operation of the manufacturer's new Rubber Seat Ball Valve. It is bubble-tight at one psi, and has successfully eliminated all jamming or wedging problems. Standard sizes range from 10 in. through 48 in.

The new ball valve is especially suited for off-on or throttling service in pipelines, discharge from dams or reservoirs, and control systems.—Henry Pratt Co.

Vitrified Clay Pipe

646

4-page Bulletin PS-101 illustrates and describes the manufacturer's Presto-Seal vitrified clay pipe that joints to a permanent, flexible seal in a matter of seconds. It features patented spigots and sockets of air-cured polyester resin and a flexible rubber compression seal.—Kaul Clay Co.

Mechanical Rack Rake

647

24-page brochure describes operation of custom-built mechanical rakes for cleaning trash racks at water intakes. It includes information on rack hoist machinery, attachments for special cleaning problems, and methods of trash removal. Diagrams and representative specifications on typical installation arrangements are also given.—Newport News Shipbuilding & Dry Dock Co.

Pneumatic Ejector

648

Bulletin 5408 gives a complete description of pneumatic ejector systems including principles of operation, construction features, operating arrangements, method of selection, air compressor and tank sizing, and layout dimensions for both single and duplex stations ranging in capacity from 30 gpm to 600 gpm.—Ralph B. Carter Co.

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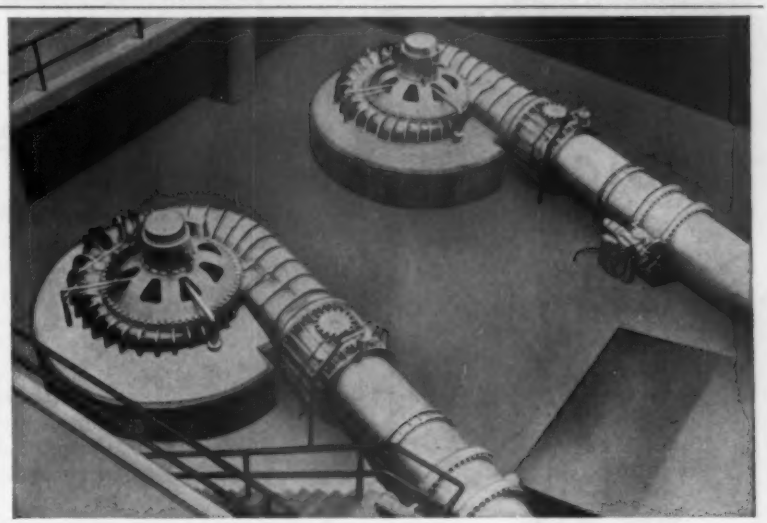

YOU'RE looking at two C. H. Wheeler 67,000 gpm Vertical, Bottom Suction, Side Discharge, Mixed Flow Dual Volute Pumps. They are operating at the Helena Valley Pumping Plant of the Bureau of Reclamation's Missouri River Project. These pumps provide sufficient irrigation water to permit the farming of 17,500 previously unproductive acres of Montana farmland.

The C. H. Wheeler Dual Volute design is especially valuable when a pump is required to operate over a wide range of operating conditions.

Both pumps have side discharge. An unusual C. H. Wheeler designed bottom suction permits taking water from the same penstock that drives the Water Turbines.

High-head, high-capacity pumps such as these have unlimited application in municipal water supply and irrigation services . . . another instance of applying C. H. Wheeler design to special pumping problems, with assurance of proper performance.

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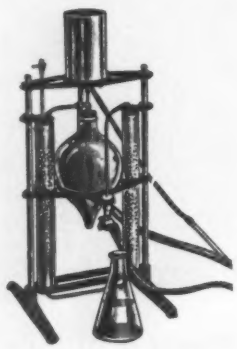

For checking the equilibrium of a finished water, and supplying an index useful in controlling anti-corrosion treatment. Catalog No. 83-895

WRITE:
Phipps & Bird, Inc.
P. O. Box 2V Richmond 5, Va.

New Literature

CONTINUED FROM PAGE 105A

Water Treatment

649

Reference folder serves as a file on activated silica sol used as coagulant aid for treating raw, process and waste waters. Advantages are cited pertinent to: improved quality of filter water; reduced raw water color and reduced turbidity; broader effective pH range of treatment; increased compaction of sludge; and effective winter and summer coagulation.

A useful table listing various processes for making activated silica sols and the advantages of each method is included.—Philadelphia Quartz Co.

Industrial Water Pipe

650

10-page Bulletin TR-254A directed to those concerned with the design and specifying of water systems for industrial plants as well as installing contractors. It describes the manufacturer's Transite asbestos-cement pipe and also includes design data and guide specifications for materials and installation. Among the applications covered are water supply mains, distribution lines, service water, process water, potable water, and cooling water supply and return lines.—Johns-Manville.

Electric Motors

651

Brochure contains technical data, feature illustrations and descriptions of the manufacturer's new line of advance-design, right-angle worm gear motors. Called the U.S. Syncrogear, the new motor is available in the single reduction Type GW and the double reduction Type GWB.

Speeds of 3.25 to 230 rpm and gear ratios up to 87:1 are shown for Type GW, and ratios up to 354:1 for Type GWB. Horsepower ratings are ⅓, ½, ¾, 1, 1½, and 2 hp.—U.S. Electrical Motors Inc.

Cement Mortar Lining of Pipe

652

This 18-page brochure presents complete information on the Spunline® process for in-place cement mortar lining of cast iron, wrought iron, concrete, corrugated metal, vitrified clay and steel pipe ranging from ½in. to 180 in. It is well illustrated with pictures and drawings and includes contract specifications.—Pipe Linings, Inc.

Clay Pipe

653

4-page Bulletin VS-20 contains illustrations that fully explain the main features of Natco Clay Sewer Pipe with "Vitri-Seal" Joints. The flexible rubber gasket retains tight seal all

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around socket under very high shear loading stresses.

This pipe conforms to all requirements of ASTM for standard and extra strength clay pipe and also for pipe joints having resilient properties. —Natco Corp.

Electric Motor

654

4-page bulletin 201 illustrates and describes the manufacturer's TYPE "AP" squirrel cage induction motor designed expressly to fit the requirements of centrifugal machine drives. Low current inrush, smooth acceleration and simplicity, are some of the advantages discussed. Photographs of motor driving centrifugal compressors and centrifugal pumps are included. —The Ideal Electric & Mfg. Co.

Storage Tanks

655

20-page brochure on the manufacturer's line of standard storage tanks contains useful tables of dimensions and capacities. It also offers a pictorial presentation of the many purposes and uses filled by cone-roof, flat bottom steel tanks for the storage of water, fuel oil, asphalt, dry materials, and many other products.—Graver Tank & Mfg. Co., Div., Union Tank Car Co.

Water Works Supplies

656

56-page catalog WW—60 describes and illustrates the manufacturer's extensive line of water works supplies. It includes specifications on pipe, mechanical joint and socket fittings, couplings, repair sleeves, and clamps, valves, indication posts, hydrants, stops, service clamps, goosenecks, water meter yokes, melting furnaces, tools and torches.—Grinnell Co., Inc.

Water Service Organization

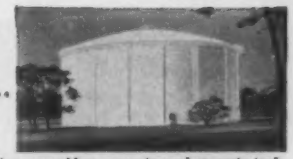
657

Bulletin 10, a 4-page brochure, gives general information on services offered by Layne & Bowler, Inc., and associate companies, to users of ground water.

Services include: initial surveys and explorations; site selection; foundation and soil sampling; well drilling; well casing; pump design, manufacture and installation; construction of water systems; chemical treatment of water wells; water treatment; maintenance and service.—Layne & Bowler, Inc.

CONTINUED ON PAGE 108A

Before you buy any storage tank...



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- Liquid feed
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- No delays

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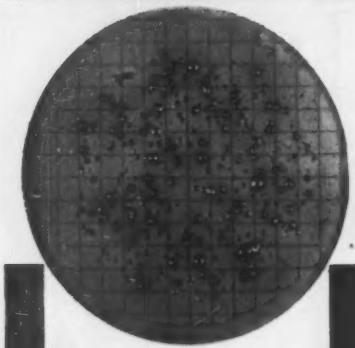

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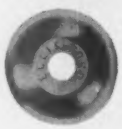

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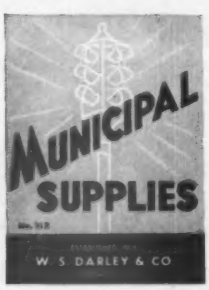

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New Literature

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Water Meters

658

28-page bulletin presents manufacturer's extensive line of Trident water meters. It discusses metering and its many advantages in solving the problem of wastage which often leads to municipal water shortages.

Bulletin also describes design features of Trident Frost—Proof disc meters, split-case disc meters, style 3 disc meters, crest meters, compound meters and fire service meters. The final section deals with testing of water meters.—Neptune Meter Co.

Differential Producers

659

8-page bulletin describes ten of this manufacturer's Differential Producers, suitable for the metering of water, air or gas, as well as petroleum, alkalies, acids and sewage. Specialized applications of Dall Flow Tubes, Hershel Standard Venturi Tubes, Venturi Flow Nozzles and the new Plastic Parshall Flume Liner are explained in detail.—B-I-F Industries, Inc.

Wet-Pit Propeller Pumps

660

4-page bulletin 2114-B1 contains technical data on manufacturer's Wet-Pit Propeller Pumps, Types KL and KM. Applications cover: drainage, irrigation, flood control, sewage effluent, water treatment, transfer pumping, cooling towers, etc. Drawings, dimension charts and sample specifications are included. Capacities to 100,000 gpm.—Worthington Corporation.

Flow Meters

661

8-page Catalog C295-1 and Instrument Data Sheet 10.3-9 describe in detail design and operating principle of Rotron Whirl-Flo meters.

Simple in design and rugged in construction, the meter measures the volume rate of liquids or gases at line conditions. The meter can be combined with a densitometer or a variety of the manufacturer's Electronik instruments to measure mass flow.—Minneapolis-Honeywell Regulator Co.

CONTINUED ON PAGE 110A

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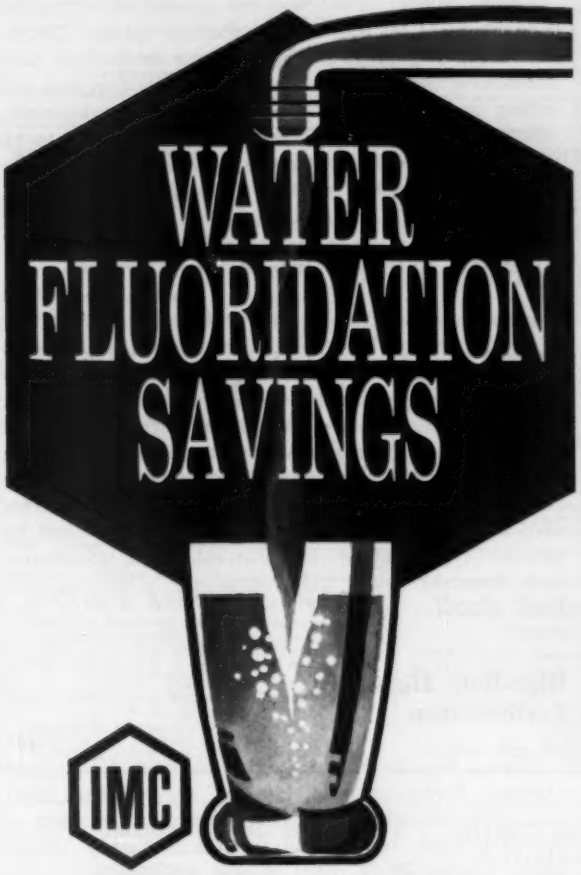

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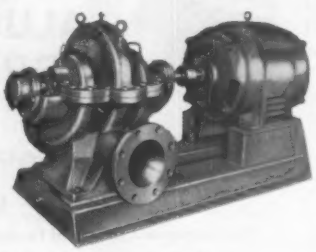

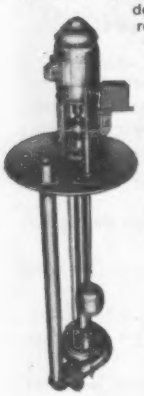

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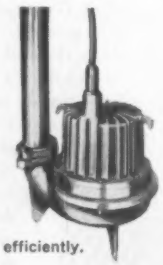

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Aerobic Digestion

662

8-page Bulletin 6650 gives full information on an expandable plant for treatment of domestic wastes. The extended aeration system can be built as a smaller unit, then increased in capacity by adding a second aeration tank and settling tank. Designed especially for tract developments, motor lodges, shopping centers and mobile home parks. Bulletin discusses in detail the advantages of the Hi-Cone System.—Yeomans Brothers Co.

Overload Release Clutches

663

Eight-page Bulletin No. 305 "Modern Clutching for Water & Sewage Treatment Plants" recently published by this manufacturer should be of special interest to water and sewage executives, engineers, and consultants.

It constitutes a treatise on automatic drive control and offers complete coverage of the functions of Centric's Trig-O-Matic Overload Release Clutches in preventing costly damages from overloads. Specific types of drives used in water and sewage plants are fully described by means of typical layout of mechanical drives, informative text, dimension tables and illustrations.—Centric Clutch Co.

High-Rate Digester Performance

664

12-page Reprint 439 of a technical paper "High-Rate Digester Performance at Jamaica" by Norman Nash and A. H. Chasick, precented at 32nd annual meeting of the New York Sewage and Industrial Wastes Association, January 20-22, 1960, is now available.

The paper describes the conversion of two of the twelve digesters in service at Jamaica Bay (New York, N. Y.) pollution control project to high-rate digesters, and their experimental operation during 1958 and 1959. —Dorr-Oliver Inc.

Water Treatment for High Makeup Boilers

665

10-page Technical Reprint T-183 entitled "Water Treatment for High Makeup Boilers Operating in the Range of 600—1,250 Lbs." discusses the selection of the proper type of water treatment equipment for use at different pressures and with different types of water.

The paper begins by examining the four basic types of treatment, and evaluating their use in typical plants with low, medium and higher solids water. It also discusses case histories of two actual plants, and concludes with a review of new treatment and testing methods, including condensate scavenging.—Graver Water Conditioning Co.

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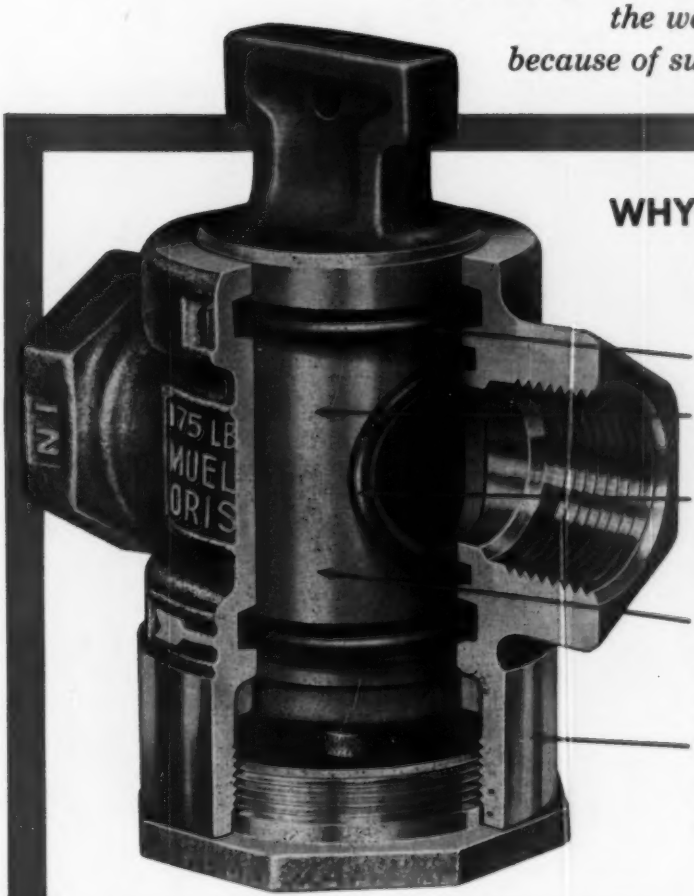

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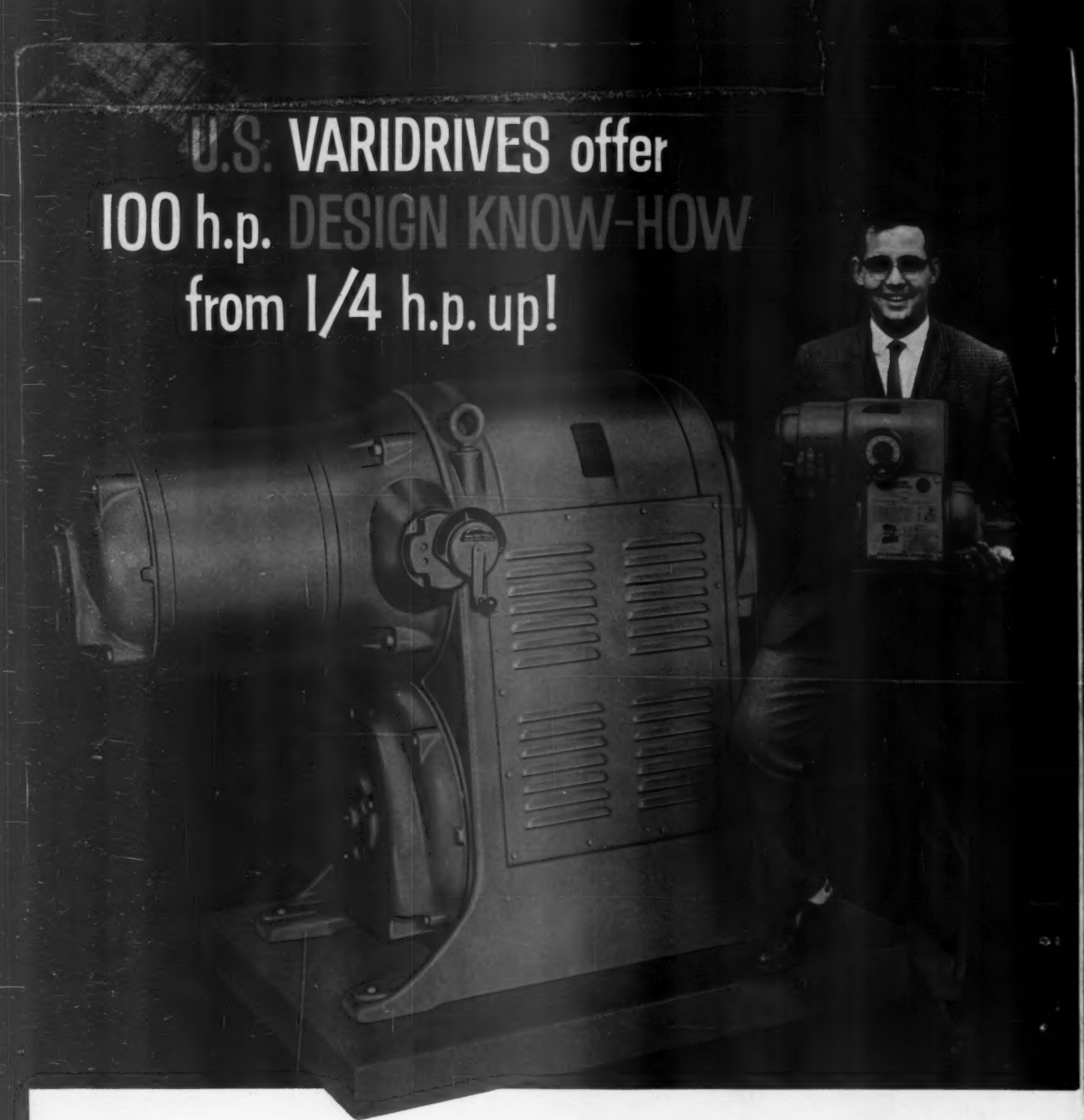

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